PROBLEMS AND PROSPECTS OF FOOD SECURITY IN INDIA

ABSTRACT
THESIS

SUBMITTED FOR THE DEGREE OF

Doctor of Philosophy

IN

AGRICULTURAL ECONOMICS AND BUSINESS MANAGEMENT

BY

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Under the Supervision of

Dr. Akram A. Khan

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AND BUSINESS MANAGEMENT
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ABSTRACT

Food security has been defined in different ways; however, the most realistically it has been defined as access by all people at all times to enough food for an active, healthy life. Its essential elements are the availability of food and ability to acquire it. There is also distinction between chronic and transitory food insecurity. Chronic food insecurity reflects continuous inadequate diet caused by the inability to acquire food. It affects households that persistently lack the ability to either buy food or to produce their own. The transitory food insecurity is defined as a temporary decline in the household's access to enough food. It results from instability in food prices, food production and household income and in its worst form it produces famine. Food security has to address both the physical and economic access to food.

Nevertheless, the most important fact is that food security is a complex issue that involves; not just production, but also access, not just output, but also process, not just technology, but also policy, not just global, but also national, not just national but also households, not just households, but also individuals, not just rural but also urban, and not just amount but also content.

Improving food security for all is a widely debated and much confused issue, but one of supreme importance to many million of people worldwide. Ensuring that all the world's population has enough food for an active and healthy life is among the most fundamental challenges we face. Ensuring food security for all is the challenge with many dimensions.

In the short run reducing hunger must focus at the household level with enabling actions by the nations. Globally, only adequate food supplies and food aid can help. In the medium term, the emphasis must be more at the national and individual levels, focusing on reducing poverty and generating sustained economic development for all. Central to that vision are concerned national and international efforts to appropriate agricultural technology to improve productivity and profitability of millions of farmers in developing countries like India. In long term, global food supplies must increase in sustainable production systems.

Now question is that how difficult is challenges of food security? There are considerable disagreements about how easy or difficult it will be to meet the challenge. Views range from "there is no problem" to "the Malthusian nightmare is imminent". Food security for all is achievable in the medium and long run if individual and families, nations and international community take the necessary action but there can be absolutely no complacency about the need for action, now what we need to do is adopt more urgent targeted measures quickly.

During its long history India always has been on the verge of food crisis. While during the past the food crisis was seen in the form of being deficient in production, recently the prominence has been shifted to purchasing power deficiency, and high persistence of poverty that dampened the growth of demand for food. Yet, it is undeniable fact that the second most populous country in the world has had a remarkable success in maintaining a high level of self-sufficiency under very difficult circumstances.

In the late 1960s, India was categorized as a lost case by the authors of Famine 1975, William and Paul paddock went to the extent of suggesting that the triage principle should be applied to food aid to India. This principal is adopted in military hospitals on the war front and is based on the practice of saving those who can be saved and not wasting resources on those who cannot be saved. India was classified under the latter category. Their analysis had convinced them that India would not be able to increase food supplies through increased production, imports and food aid, to match its population growth and they predicted large-scale starvation.

When India's imports of cereals had reached an alarming level in the middle of the 1960s, a new agricultural strategy was adopted in the country as a result; the production of food grains in India underwent a radical change from the mid 1960s onwards and consequently, in 1968, a several thousand years old barrier in the yield of wheat was broken and India achieved a wheat production of 17 million tons. An American scientist Dr. William Gadd called the dramatic breakthrough the Green Revolution. The advent of Green Revolution was at a time when the availability of further land had more or less reached to its limits, and the agricultural scenario changed from one of land reclamation to one heavily dependent on modern inputs. The introduction and rapid spread of high yielding rice and wheat varieties resulted in a steady output growth for food grains. Public investment in irrigation and other rural infrastructure and research and extension, together with improved crop production practices, significantly helped to expand production and the stock of food grains. The production, which was 72 million tons *in 1965-66, rose to 195 million tons in 1998. Imports, which averaged 6 million tons per year from the mid 1960s to mid 1970s, have been negligible in recent years. The Green Revolution had a dramatic effect on food security in India. It enabled India to escape rising import dependence and periodic food shortages. It has also contributed to lowering prices of main food staples by increasing their supplies, and between 1980s and 1990s India Managed to become net cereal exporter. In the last two decades, however, concerns have arisen about the health of cereal production systems in India. A large absolute increase in population raises serious concerns about whether India's production system will be able to feed so many people, especially in the face of a possibly stagnant or even declining natural resources.*

Recent signs indicate that phenomenal Green Revolution growth in productivity is slowing, especially in the intensively cultivated low lands. Since the early 1990s, rising unit production costs have led to a decline in farmer profits in India. Slackening off investments in infrastructure and research and reduced policy support partly explain the sluggish growth. The precipitous drop must be a cause for concern for a country that still has a massive amount of food insecurity despite overall cereal self-sufficiency. Degradation of the lowland resource base from long-term, intensive use also has contributed to declining productivity growth rates. Similarly, the full diffusion of modern technologies in the northwest and the stagnation of agricultural productivity in rest of the country contribute to the decline. Environmental and resource constraints have also contributed significantly to the slowdown in yield growth evident over the last two decades.

The precipitous drop must be a cause for concern for a country that still has a massive amount of food insecurity and a high rate of population growth, despite overall cereal self-sufficiency.

However, intensification per se is not the root cause of lowland resource base degradation; rather, a policy environment that encourages monoculture systems and excessive or unbalanced input use is to blame. Trade policies, output price policies, and input subsidies, particularly for water and fertilizer have all contributed to the unsustainable use of the land base. The dual goals of food self-sufficiency and sustainable resource management are often mutually incompatible. Policies designed for achieving food self-sufficiency tend to undervalue goods not traded internationally, especially land, water, and labor resources. As a result, food self-sufficiency in India came at a high ecologic and environmental cost. Appropriate policy reform at both macro and sectoral levels will go a long way toward arresting and possibly reversing the current degradation levels, but the degree of degradation in many regions will pose severe policy challenges. But even if environmental degradation in intensive India's cropping system were stabilized, it is unlikely that previous crop yield growth rates will be restored, as long as research and infrastructure investments continue to decline.

The trend in slowing yields and production in India is more of a supply phenomenon and thus more of a cause of concern. Per capita rice and wheat consumption in India are still well below Chinese levels. Energy and protein supplies in India only grew at a rate of 1 percent per year between 1980 and 1995, and that the developing world as a whole has increased per capita energy supplies

twice as fast as India since 1960. thus, despite overall food self-sufficiency average supplies of energy and protein in India are insufficient to meet average needs.

The problem of food insecurity in India has become more complex with the presence of 286 million of malnourished people in India whose calorie intake is less than 90 percent of basic requirement of 2700 calorie per day. The high persistence of poverty in India has dampened cereal demand growth. Additionally, 90 percent rural and 70 percent of urban population are facing problem of risk of entitlement failure. Furthermore, there are also concerns about new challenges of globalization and reforming a food management and subsidy system that resulted in encouraging in monoculture system of wheat rice, excess food stocks with Government agencies, and unbalanced input use. Indian policy makers currently face the difficult challenge of dismantling a heavy state centered food production system that has historically involve heavy input and consumption subsidies as well as import and export controls. Beyond wastefulness and inefficiencies associated with such policies, a record of slow per capita consumption growth and persistent food insecurity on a massive scale speaks for itself. Given the realities of local production capacity, Indian policymakers must acknowledge the fact that food self-sufficiency is not a viable option if the nation wishes to achieve true food security in foreseeable future.

In brief the challenge before India is to resolve problem of poverty and hunger through agricultural led growth. The advances in new sciences of biotechnology provide India with new window of opportunity to deal with issue of food security and hunger. Scientists, agronomists, and policy makers have been looking for the

next revolution in agriculture, a revolution that should be evergreen and sustainable. For many, it is biotechnology, which holds this promise. It is now largely considered that if handled in responsible manner biotechnology represents a revolution with immense potential impact for the well being of the mankind. Hence to solve Indian food problems in a sustainable manner, India must seriously consider the option of adopting advances in agricultural biotechnology. While agricultural biotechnology can provide an important instrument in halving problem of hunger and food insecurity, the complexity and long prevalence, and nature of problem makes it impossible to have biotechnology as single solution. There is also need to invest more in human resources, and rural infrastructure, and agricultural research. Equally, there is need of explaining new functions and responsibilities to the main actors including Government, NGOs, farmers, and research organizations in the context of globalization in order to make integration of India's economy with the world economy a turning point in poverty reduction and achieving a food secure India for all.

Finally, with business as usual, food insecurity will remain widespread. Many millions of people will suffer from hunger and its debilitating consequences. This does not have to be so. For this, one would need to mobilize the revolutionary developments in information technology and biotechnology for the benefit of poor and food insecure, to renew our investments in the factors essential for agricultural growth, including agricultural research and human resource development, and to strengthen agro-ecological approaches; to harness the political will to adopt sound policies for eradicating poverty, fostering food security, and protecting natural *resources; and to alter our behaviors and priorities to assure sustainable development. This is not an insurmountable task. Building on the progress made and embarking on new strategies and initiatives should enable us to finally realize a food secure India in the twenty first century.*

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Give me the will to know and the will to learn, O Ahura Mazda! Let me keep on learning all my life. Let me gather information and instruction from anywhere and everywhere.

Dedicated to my wife and son

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Dr. Akram A. Khan **Dated:** 18 Nov. 2002

To Whom It May Concern

This is to certify that ***Mr. Farhad Shirani Bidabadi*** has worked for his Ph.D. degree under my supervision on ***"Problems and Prospects of Food Security in India".*** The Ph.D. thesis is his original work and is fit for submission for the Ph.D. degree in Agricultural Economics and Business Management.

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Farhad Shirani Bidabadi

Farhad Shirani Bidabadi

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Chapter 1
Introduction

Introduction:

In 1968, a several thousand years old barrier in the yield of wheat was broken and India achieved a production of 17 million tons. An American scientist Dr. William Gadd called the dramatic breakthrough the Green Revolution. 34 years and a record production of nearly 200 million tons later, India seems up against another yield barrier.

For the past decade, notwithstanding an overflowing granary, the issue of self-sufficiency has come up again, but with complex dimensions. These include questions of high cost of self-sufficiency, sustainable agriculture and need to focus on nutritional security. The new concerns are rising from the fact that average per capita food availability has been stagnating, if not actually declining, public investment in agriculture has failed to pick up and intensive input use has degraded the ecology of the grain bowls of the country.

While the government rejoices over a record food grain production, there are doubts about the country's ability to produce enough to meet demand by 2020. While there was no immediate cause for concern in the last decade on food production front. Indian agriculture would face severe environmental problems in the decades to come. The pessimistic projection of India's ability to meet future production targets arise from environmental issues and problem of resources, India doesn't have adequate resources to invest in degraded land, conservation of forest and research.

Worse, even as scientists claim that the current food grain production indicates food security in the immediate future, economists are more doubtful. A buffer stock of 60 million tons may look good but even as thousands of tons of grains are beginning to rot in government agencies stores the starvation death reports are coming from different states of the country specially the poorest ones. This raises questions in various forums on whether India has actually achieved food security.

Food security has to address both the physical and economic access to food. The production of around 200 million tons seems to have addressed the former. Economic access, in terms of enhancing purchasing power of the poor, however, is still a far cry. And thanks to low effective demand for food grains, the buffer stocks continue to grow.

Food production has risen in the recent decades but have food problem been solved? Certainly not. Does a buffer stock of 60 million tons gives India any satisfaction or enhanced its prestige? Of course not. If the sufficient purchasing power is given to the Indian poor, the buffer stocks will disappear, and real dimensions of the food problem shall become known only then.

Scope and Objectives of Study:

In this work an attempt has been made to gauge the problem of food security in India. The work presents the issues and reviews policies and programs to improve food security. Food security problem has multiple dimensions that range from ensuring food supply at global, country and local levels to ensuring sufficient effective demand for adequate food consumption. The ultimate goal of an effective food security policy is to provide for individuals adequate dietary intake through availability and accessibility of food, which are necessary conditions for nutritional well being. To improve the food security situation, the specific nature of population's food security problem must be well understood. In this work, my endeavor is to understand it. This work begins by defining food security with the objective of clarifying and conceptualizing the key issues. The dimensions of food security at different levels are then described and food insecure people in different economic contracts are identified. The work continues with the study of management of food system in India and effects that new science of biotechnology can have on food security in India. The work concludes with a synthesis of recommendations for priority policy action.

As title of work illustrates, the main objective of study is to examine different aspects of problem of food security in India. As food security problem in a country with the size and magnitude of India is not a single headed problem, the objective of any study on food security cannot be a single one. Thus, the main objective is divided into different sub-objectives, including:

1) To develop a theoretical base for definition of food security.
2) To measure the size and magnitude of food security problem.
3) To assess the risk of failure of food entitlement for different segments of population.
4) To assess future food demand and supply situation in India.
5) To give a brief account of food production in India and problems special to food production.
6) To analyze the effects of phenomenon like globalization and commercialization of agriculture on food security in India.
7) To revise current management system of food economy and the reforms, which

are, required for making the system more effective.

8) To study the effects of noble science of biotechnology on food security in India and required policy actions to make it more effective in Indian context.

Hypothesis Tested:

Keeping in Mind objectives of the study, following hypothesizes have been tested in this work:

1) India has achieved food self-sufficiency.
2) Physical access to food reached to optimal level in India.
3) All sections of population in India are well fed.
4) The access to and availability of food are risk free for all.
5) India will not face problem of food gap in future.
6) Globalization has negative effects on food security situation in India.
7) India's food subsidies are reaching to the target group efficiently.
8) Biotechnology is able to address problem of food security in India.

Methodology Adopted:

For the purpose of measuring food security situation in any given society International Food Policy Research Institute have developed four standard methods including:

1) *Individual Food Intake Data;* this is a measure of calorie, or nutrients, consumed by an individual in a given time period usually 24 hours.
2) *Household Calorie Acquisition;* this is the number of calories, or nutrients, available for consumption by household members over a defined period of time.

3) *Diet Diversity;* this is the sum of the number of different foods consumed by individual over a specific period of time.

4) *Indices of Households Coping Strategy;* this is an index based on how households adopt to the presence or threat of food shortage.

IFPRI (International Food Policy Research Institute) further compared these four methods in terms of costs, time, skill requirement, and susceptibility to misreporting (Box 1).

Box 1: Comparison of Methods in Terms of Costs, Time, Skill Requirement, and Susceptibility to Misreporting.

Method	**Individual Calorie Intake**	**Household Calorie Acquisition**	**Diet Diversity**	**Index of Copping strategies**
Data collection costs	High	Moderate	Low	Low
Time required for analysis	High	Moderate	Low	Low
Skill level required	High	Moderately High	Moderately Low	Low
Susceptibility to Misreporting	Low	Moderate	Low	High

Source: Hoddinot, 2001.

Keeping in mind the availability of a good set of individual calorie intake data with National Sample survey Organization (Government of India), the Individual Calorie Intake data has been selected as basic methodology for measurement of food security in India.

To assess risk factor, coefficient of variation (CV) of production, availability, yield, and area under food grain calculated. This practice has been repeated in case of calorie, protein, and fat also. Based on Engles law a simple method has been developed to assess risk of entitlement failure (a detailed account of method has been given in chapter five).

To assess future food demand in India, besides projections, which have been done by several research institutions and individuals, a projection based on definition of food security has been presented in chapter 3. This projection is based on recommended food norms of ICMR (Indian Council of Medical Research).

Sources of Data:

In this work secondary data from different sources (government and non governmental sources have been utilized. These sources include:

1) Household and individual Calorie Intake Data, National Sample Survey Organization.
2) Household and Individual consumption expenditure, National Sample Survey organization.
3) Economic Survey, different years.
4) Statistics at a Glance, Department of Agriculture & Co-operation (Government of India).
5) Food Balance Sheets of Food and Agricultural Organization of United Nation.
6) Data Available on different publication of International Food Policy Research Institute (IFPRI).
7) Data on development and application of agricultural biotechnology from the International Service for the Acquisition of Agri-biotech Application (ISAAA).

History of Famine and Hunger in India:

Food insecurity is not a new affliction. Recurrent famines as well as endemic undernourishment have been persistent features of history. Life had been short and hard in much of the world, most of the time. Deprivation of food and other necessities of living have consistently been among the casual antecedents of the brutishness and brevity of human life.

Ancient chronicles not only in India, but also in Egypt, Western Asia, China, Greece, Rome, North-East Africa, and elsewhere tell us about famines (worst form of food insecurity) that ravaged ancient civilizations in different parts of the world. Even when literary accounts are scarce or do not exist, archaeological data and other historical evidences tell stories of sudden depopulation and frantic migration, in addition to providing information concerning nutritional debilitation and significant stunting. Thus, hunger, food insecurity, and malnutrition are not modern malady. However, they are intolerable in the modern world in a way it could not have been in the past. This is not so much because it is more intense, but because widespread hunger is so unnecessary and unmerited in the modern world. The enormous expansion of productive power that has taken place over the last few centuries especially during second half of 20th century has made it, perhaps for the first time, possible to guarantee adequate food for all, and it is in this context that the persistence of chronic hunger and the recurrence of virulent famines must be seen as being morally outrageous and politically unacceptable. If politics is 'the art of the possible', then conquering hunger has become a political issue in a way it could not have been in the past.

Food security on the one hand, and famine on the other are inversely related concepts. Ensuring food security is equated to avoiding of famine and hunger. Famine is a disaster of food insecurity. Robert Klinterberg (1977) described famine, as "an event which disrupts the functioning of a community to such an extent that it can not subsist without outside assistance". According to Wolde-Moriam (1984), famine is a "general hunger affecting large numbers of people as a consequence of non-availability of food for a relatively longer time". The one good thing about famine is that it does not strike unexpectedly, but builds up slowly and provides a lead-time slowly before it occurs. In other words the predictability of famine makes it possible to prevent it. If a food shortage develops to the scale of famine, it must therefore be the weakness of society in general and government in particular. In this sense, famine is a man made disaster (Aylew, 1988).

Failure of rains, and consequently of crops has been known in India from the earliest times. Hymns invoking rains in Rig Veda, mention of excess of rain or droughts damaging crops in Atharva Veda and many such references made in Jataks prove occurrence of famines in those times. Megasthenes, the envoy of Selecckos, Nikator to the court of the Indian emperor Chandaragupta Maurya in the fourth century BC, wrote (perhaps to impress his gullible Greek readers) that famine was completely unknown in Maurya India. But Kautilya, the Indian political economist, who was an official adviser to Chandragupta, wrote extensively on how to deal with famine. In the time of Chandragupta Maurya, there occurred a severe famine in 298 B.C. in Bihar, which is said to have lasted for a long period.

A terrible famine occurred in Kashmir in 917-18 A.D. when one could scarcely see the water in River Jhelum. The river was entirely covered with corpses, soaked and swollen by the water in which they had long been lying. The earliest reference to famine in medieval India is that of 1291 A.D., which occurred in the reign of Jalaluddin Khilji, severely affecting parts of Delhi and Siwalik Hills. In 1326-27 A.D. rain failed and affected severely parts of Doab. The second famine which occurred in the 1334-35 during the reign of this monarch, was much more severe and lasted for seven years. In the last decades of the fourteenth century, South India experienced a severe famine in 1396, causing death of a large number of persons. In 1412-13 a famine affected South India followed by one in 1424, when multitudes of cattle's died on the parched plain for want of water. Bahmani Kingdom in 1407 and Maharashtra in 1509 were badly affected by Famine, in 1540 larger number of people died in Vijaynagar Kingdom due to famine caused by war. It was so severe in Mysore that cannibalism was reported.

During the reign of Akbar famines occurred three times; once in 1556 in the area surrounding Delhi, then in 1575 in Gujarat, and the third one which was very disastrous and continued for four years (1595-99) in Northern India. The next severe calamity occurred in the days of Shahjahan in 1630 in Gujarat and Deccan. This is said to be one of the greatest famines recorded in history, and the first about which precise details, especially by a Dutch merchant named Tuist are available. It is said that in Swally only 11 out of 260 families survived; in Surat, a populous city at that time, nearly 30 thousand perished and hardly any life survived; and on the road between Surat and Swally there was a very large number of bodies decaying. W.W. Hunter in history of British India described it as the garden of the world being turned into wilderness. The other severe famine occurred in the day of Aurangzeb in 1686 in Deccan stretching up to Gujrat. In the same area another famine visited in 1747.

About a dozen famines occurred during the period of East India Company in 1769-70 in Bengal, in 1783 in North India, in 1790-92 in the Deccan especially Bombay and Hyderabad, in 1800 in Mysore, in 1803 in Bombay, in 1804 in North India, in 1807 in Madras, in 1813 in Bombay, in 1823 and 1833 in Madras, and in 1837 in North India. Out of these, four (first three and last one) were very severe. In 1769-70 in Bengal one third of inhabitants or about 10 millions died. There was a tremendous decrease in cultivation and about one third of the cultivated land turned to waste. In 1783 came the Chalisa famine in Northern India, extending from eastern parts of Banaras Province to Lahore and Jammu. It continued the next year also, and in 1784 famine conditions prevailed in Madras also. The horrors of this famine have been symbolized in local songs. In place of grain, it is said that people took roots and bark of trees. Hastings wrote to the Council Board in April 1784 that from Buxar to the opposite boundary (of Banaras Province) I have seen nothing but complete devastation in every village; and Edwards 1783 found Oudh that was quite populous at that time 'forlorn and desolate'. In 1790-92 came the Doji Bora or Skull Famine of Deccan. It extended over the whole of Bombay and Hyderabad and affected northern districts of Madras. Another severe Famine occurred in 1837-38 in northern India especially in the upper reaches of the Ganges and the Jammuna.

During the rule of the crown there have been eight major disasters, which about them sufficiently precise and reliable details are available. In 1860-61 there was a famine in Northern India especially in parts of Northwestern province around Agra, Punjab and touched Rajputana and Cutch. The total area affected was 53,500 sq. miles with a population of 20 million. From 1865 to 67 another severe famine affected the whole east coast form Calcutta to Madras penetrating for inland. It began in Orissa, generally known as the Orissa famine of 1866. The total area affected was 180000 sq miles with a population of 47 million. In Orissa alone at least 1 million or about one third of the total population died, and in some of the divisions of Bengal about one fourth of the population died. This famine in the Eastern part was soon (almost on its heels) followed by one in the Western part in 1868 to 1870. It extended over Rajputana, parts of Northwest province, Punjab and Bundelkhand. This is commonly known as the Rajputana famine of 1868-69. It affected 29600 sq. miles and about 45 million, people.

Another famine quickly followed in 1873-74 covering Bihar and adjacent parts of Bengal and Uttar Pradesh. It affected an area of 54,000 sq miles with a population of 22 million, but the distressed area was 40,000 sq. miles with a population of 17 millions. In the decade of 1870-80 a series of famines occurred covering almost the whole of the country. Almost immediately after famine in North India there was a famine in the Deccan for two years, 1876-78. It affected major portions of the residencies of Madras, Bombay, Mysore and Hyderabad. It occurred first in the Deccan and in 1878 was extended to North West province and Oudh. The Cambridge History of India considers it the most widespread and fatal in the 19th century and Imperial Gazetteer of India regards it to be more widespread than any other calamity. Perhaps its implication is better expressed by the

Famine Commission of 1880 which described it as the worst experienced since the beginning of the British rule up to that time, 5.25 million deaths occurred, vast tracts of agriculture land were left uncultivated and there were continuous streams of people migrating from different pats of South India to the Western Ghats.

For about a decade and half, roughly from 1880 to 1895, there was no severe famine but there had been several local scarcities such as 1884-85 in Bengal, in 1889 in Orissa and from 1890 to 1895 in parts of Madras. In 1896-97 famine conditions prevailed in Northwestern province, Oudh, Bihar, Bengal, Punjab, Madras, C.P., and Bombay.

In 1890-1900 another famine occurred which is said to be not so widespread, but was certainly quite severe. For four decades since 1901 there was no serious calamity though localized famine conditions had occurred frequently, such as in 1902-3 in Central provinces, in 1905-6 in U.P. and Punjab, in 1907-08 in U.P., Bengal, C.P. and Bombay, and in 1918 in Punjab, U.P., Bombay, C.P., Bihar and Orissa.

The most recent severe famine occurred in Bengal 1943. It has been estimated that about 6 million or one tenth of total population of Bengal was affected and about 1.5 million people died as a result of famine and the accompanying epidemics of cholera, malaria, small pox and dysentery which caused as many deaths as starvation itself.

No large-scale famine visited India after independence in 1947, but it does not mean the problem of hunger has been solved, hunger starvation and food insecurity existed as a part of independent India also. Thus, it is true to say that these problems have been a part of Indian history since the beginning of civilization in this part of world.

CONCEPTUAL FRAMEWORK FOR FOOD SECURITY

Concept of Food Security:

Food security is a complex and ticklish issue, as its meaning and interpretation varies widely across the countries. It is a concept that has been evolved over the last quarter of century. The term food security was given attention for the first time at the 1974 World Food Summit; the summit recognized that food security as a common responsibility of all nations and called for international approaches to achieve a food secure world.

In 1992, 159 states and European Economic Community participated in the International Conference on Nutrition they released a world declaration on nutrition. All nations involved at the conference agreed that hunger and malnutrition are unacceptable and that access to nutritionally adequate and safe food is a right of each individual.

In 1996, more than 180 nations participated in a World Food Summit and committed to decreasing the number of undernourished people to half their present level no later than the year 2015. While progress has been made, it now appears that this goal will not be met. The heads of states or their representatives reaffirm that a peaceful, stable and enabling political, social and economic environment is essential foundation, which enable states to give adequate priority to food security and poverty eradication. Democracy, promotion and protection of all human rights and fundamental freedoms, including the right to development, and the full and equal participation of men and women are essential for achieving sustainable food security for all. The Rome declaration on world food security further emphasized that; poverty is a major cause of food insecurity and sustainable progress in poverty eradication is critical to improve access to food. Conflict, terrorism, corruption and environmental degradation also contribute significantly to food insecurity. Increased food production including staple food must be undertaken. This should happen within the framework of sustainable management of natural resources, elimination of unsustainable patterns of consumption and production, particularly in industrialized countries, and early stabilization of the world population. They also acknowledge the fundamental contribution to food security by women, particularly in rural areas of developing countries, and the need to ensure equality between men and women. Revitalization of rural areas must be priority to enhance social stability and help redress the excessive rate of rural urban migration confronting many countries.

The Evolution of Concept:

During the past twenty-seven years or so. Food security concept has been considered at global, regional, national, state, household and individual levels. In the early years, food security implied arrangements for providing minimum level of food grains for the population in the developing countries during years of normal as well as poor harvests (Reutlinger, 1977). It was realized that fluctuations in food supplies overtime and unstable food prices were the chronic problems of food security and that they required national and international solutions such as inter-regional grain reserves of buffer stocks, grain insurance and similar other measures (Johnson, 1976, Valdes 1981, and Konandreas et al., 1978).

Subsequent to the first period it was recognized that physical availability alone would not ensure economic access to food for all population, especially the poor and vulnerable sections. Consequently, it was emphasized that satisfactory production levels and stability of supplies should be matched by a reduction in poverty and an increase in the effective demand to ensure economic and physical access for the poor.

The next part gives a brief account of evolution of concept of food security since 1970s.

I. A Focus on National Food Security with an Emphasis on Food Supply (1970s):

In the past several years, much conceptual progress has been made in our understanding of the processes that lead to food insecure situation for households (Frankenberger, 1992). In the 1970s food security was mostly concerned with national and global food supplies. The food crisis in Africa in early 1970s simulated a major concern on the part of international donor community regarding supply shortfalls created by production failures due to drought and desert encroachment (Davis et al. 1991). This primary focus on food supplies as the major cause of food insecurity was given credence at the 1974 world food conference.

II. A Focus on Household Food Security with an Emphasis on Food Access (1980s):

The limitation of the food supply focus came to light during the food crisis that again plagued African countries in the mid 1980s. It become clear that adequate availability at the national level did not automatically translate into food security at the individual and household levels. Researchers and development practitioners realized that food insecurity occurred in situations where food was available but not accessible because of an erosion to people's entitlement to food (Borton and Shoham 1991). Sen's (1981) theory on food entitlement has a considerable influence in this change in thinking representing a paradigm shift in the way that famines were conceptualized. Food entitlements of households derive from their own production, income, gathering of wild foods, community support (claims), assets, migration etc. Thus a number of socio-economic variable have an influence on a household's access to food. In addition, worsening food insecurity was viewed as an evolving process where the victims were not passive to its effects. Social anthropologists observed that vulnerable populations exhibited a sequence of responses to economic stress, giving recognition to the importance of behavioral responses and coping mechanisms in food crisis (Frankerberger 1991). By the late 1980s donor organizations, local governments and NGOs began to incorporate socio-economic information in their diagnosis of food insecurity.

The household food security approach that evolved in the late 1980s emphasized both the availability and stable access to food. Thus, food availability at the national and regional level and stable and sustainable access at the local level were both considered essential to household food security. Interests was centered on understanding food systems, production systems, and other factors that influence the composition of food supply and a household's access to that supply over time.

III. A Focus on Nutritional Security with an Emphasis on Food, Health and Mother and Child Care (Early 1990s):

Work on the causes of malnutrition demonstrated that food is only one factor in the malnutrition equation, and that in addition to dietary intake and diversity, health and disease, and maternal and child care are also important determinants (UNICEF, 1990). Household food security is a necessary but not sufficient condition for nutritional security researchers found that there were two main processes that have a bearing on nutritional security. The first determines access to resources for food for different households. This is the path from production or income to food. The second process involves the extent to which the food obtained is subsequently translated into satisfactory nutritional levels (World Bank 1989). A host of health, environmental and cultural/behavioral factors determine the nutritional benefits of the food consumed; this is the path from food to nutrition (IFAD, 1993).

IV. A Focus on Household Livelihood Security (Late 1990s):

Research work carried out in the late 1980s and early 1990s indicated that the focus on food and nutritional security as they were currently conceived needed to be broadened. It was found that food security is but one subset of objectives of poor households; food is only one of a whole range of factors which determined why the poor take decisions and spread risk, and how they finally balanced competing interests in order to subsist in the short and longer term (Maxwell and Smith 1992). People may choose to go hungry to preserve their assets and future livelihoods. It is misleading to treat food security of a fundamental need, independent of wider livelihood consideration.

Thus, the evolution of the concept and issues related to household food and nutritional security led to development of the concept of household livelihood security. The household livelihood security model allows for a broader and more comprehensive understanding of the relationships between the political economy of poverty, malnutrition, and dynamic and complex strategies that the poor use to negotiate survival. The model places particular emphasis on household to be only one of the priorities that people pursue. People are constantly being required to balance food procurement against satisfaction of other basic material and nonmaterial needs (Maxwell and Frankenberger 1992).

Definition of Food Security:

The terms "Food Security" and "food insecurity" are both widely used by scientists and policymakers. The "ad hoc Expert Panel" (Department of Health and Human Services, & American Institute of Nutrition) developed definitions of both terms from definitions of several groups (Busch L., & Lacy, W.B., 1984; Campbell, C.C., et al., 1988; Cohen, B.E., & Burt, M.R., 1989; Margen, S., 1989; Radimer, K.L., et al., 1989; Reutlinger, S., & van Holst Pellekaan, J., 1986). Food Security is defined as access by all people at all times to enough food for an active, healthy life and includes at a minimum:

1. The ready availability of nutritionally adequate and safe foods, and
2. The assured ability to acquire acceptable food in socially acceptable ways (e.g., without resorting to emergency food supplies, scavenging, stealing, and other coping strategies) (Life Sciences Research Office, Federation of American Societies for Experimental Biology, 1990).

Food Security, a term often used in discussions of international hunger, refers to the ability of a country to provide adequate amounts of food for its population. While in other countries, the issues might involve a lack of available food products. Instead, it reflects problems of availability, affordability and accessibility of food through conventional food channels. Food security is defined as all people obtaining a culturally acceptable, nutritionally adequate diet, through non-emergency (or conventional) food sources, at all times. Food security differs from hunger in that Food Security is a problem that a community in a country, state, city, or neighborhood experiences, while hunger is a problem that individuals experience (Cohen & Burt, 1989).

Margen (1989) defines Food Security as a condition in which all people have access to (all times) nutritionally adequate food through normal food channels.

The Food Security definition requires an examination as to whether people have access to nutritionally adequate food through normal food channels. So, to measure food security for an individual or household, we need to know essentially three things. First, what is the cost of a nutritionally adequate diet in the area where the individual or household lives? Second, does the individual or household have the financial and other resources to obtain this food from normal food sources? (Examples of other resources would include transportation and physical and mental capacity to obtain food). Third, what is an individual or household's actual experience in obtaining adequate food? In other words, what are the difficulties encountered; the dependency on emergency food sources, changes in diet and meal patterns forced by problems in getting food, health and social consequences of problems in obtaining adequate food, and so on. (Neuhauser, 1989).

Food security has at least three dimensions: the first of these is availability having enough food available for the entire population at all times to sustain human life. To accomplish this, we must have a production system that

1. Produces enough in the short run,
2. Is sustainable in the long run,
3. Does not place undue risks on agricultural procedures, and
4. Responds rapidly to disruptions in the food supply due to natural disasters, civil disturbances, environmental imbalances, or other causes.

A second dimension of Food Security is accessibility. The food supply must not be limited by what economists call "effective demand". Low-income populations and inner city residents must have equal access to the food supply. Simply making food available is not enough; one must also be able to purchase it.

A third dimension of Food Security is adequacy. An adequate food supply will provide for the differing nutritional needs of the various segments of the population. Adequacy can be conceptualized in terms of balanced diets, offering the necessary variety of foods throughout the year. At the same time, an adequate food supply will provide food that is free from disease and toxic substances.

Moreover, each dimensions of Food Security must also consider the social, economic and health costs and benefits of the food system as it is presently organized. A secure food system should not impose undue social, economic, or health costs on any special segment of the population (Busch and Lacy, 1984). Food Security has been defined here as having three dimensions availability, accessibility, and adequacy. Wittwer (1980, 1982, and 1983) added a fourth, that of dependability. Of equal importance to that of production itself is dependability of supply.

Food Security is access by all people at all times to enough food for an active, healthy life, and includes at a minimum:

1. The ready availability of nutritionally adequate and safe foods; and
2. The assured ability to acquire personally acceptable foods in a socially acceptable way (Campbell, 1990).

Food Security is defined as all people obtaining a culturally acceptable, nutritionally adequate diet, through non-emergency (or conventional) food sources, at all times (Cohen, 1990).

Food Security has been defined as: "access by all people at all times to enough food for an active, healthy life" (Campbell, Katamay, Connolly, 1988).

The World Bank (1986) has defined food security as access by all people at all times to enough food for an active, healthy life. Its essential elements are the availability of food and ability to acquire it. World Bank further has made a distinction between chronic and transitory food insecurity. Chronic food insecurity reflects continuous inadequate diet caused by the inability to acquire food. It affects households that persistently lack the ability to either buy food or to produce their own. The transitory food insecurity is defined as a temporary decline in the household's access to enough food. It results from instability in food prices, food production and household income and in its worst form it produces famine. As mentioned by Von Braun and his colleagues in an International Food Policy Research Institute document published in 1992 the two types of food insecurity are in reality closely interlinked.

FAO (1983) has enlarged concept of Food Security so as to include the following components:

(a) The ultimate objective of world food security should be to ensure that all people at all times have both physical and economic access to food they need.

(b) Food security should have three basic aims, ensuring production of adequate food supplies, maximizing stability in the flow of supplies, and securing access to available supplies on the part of those who need them.

(c) Action will be needed on a wide front including all factors that have a bearing on the capacity of both countries and people to produce or purchase foods, while cereal will continue to be the main focus of attention, action should cover all basic food stuff necessary for health, agriculture and rural development, food production, food reserves, the functioning of national and international cereal market. The foreign exchange needs of importing countries, trade liberalization and export earning, the purchasing power of poorest strata of the population, financial resources and technical assistance, the flow of food aid and arrangements to meet emergency needs.

This broader concept of Food Security is similar to that adopted by the World Bank 3 years later in its position paper Poverty and Hunger: Issues and Options for Food Security in Developing Countries. The 1986 World Bank Policy Study Poverty and Hunger concluded that:

- Food Security is access by all people at all times to enough food for an active, healthy life. Food insecurity, by contrast, is lack of access to enough food. Countries that have many people suffering from under nutrition have a national food security problem.
- Ensuring Food Security entails meeting two conditions. One condition is ensuring that there are adequate food supplies available, through domestic production or imports. The other is ensuring that households whose members suffer from under nutrition have the ability to acquire food, either because they produce it themselves or because they have the income to acquire it (Rentilinger and van Holst Pellekaan, 1986).

Food insecurity can be measured at several different levels or units of analysis. The exact dimensions that need to be measured vary, depending on the unit of analysis chosen (national, community, household, or individual levels).

Three dimensions of food security need to be measured at the community level:

1. The quantity and quality of available food;
2. Its accessibility; i.e., physically, in terms of grocery store location and transportation systems, and
3. Affordability or price relative to the ability to marshal resources.

At the individual and household levels, four dimensions (quantity, quality, psychological acceptability, and social acceptability) need to be measured to identify food insecurity. At the individual level these measures are adequacy of energy intake, adequacy of nutrient intake, feelings of deprivation or restricted choice, and normal meal patterns, respectively. At the household level, they are repleteness of household stores, quality and safety of available foods, anxiety about food supplies, and sources of food (conventional or otherwise), respectively (Life Science Research Office, Federation of American Societies for Experimental Biology, 1990).

Food Security is defined in its most basic form as access by all people at all times to the food needed for a healthy life. Achieving Food Security has three dimensions; first, it is necessary to ensure a safe and nutritionally adequate food supply both at the national level and at the household level. Second, it is necessary to have a reasonable degree of stability in the supply of food both from one year to the other and during the year. Third, and most critical, is the need to ensure that each household has physical, social and economic access to enough food to meet its needs. This means that each household must have the knowledge and the ability to produce or procure the food that it needs on a sustainable basis. In this context, properly balanced diets that supply all necessary nutrients and energy without leading to over consumption or waste should be encouraged. It is also important to encourage the proper distribution of food within the household, among all its members (International Conference on Nutrition, 1992).

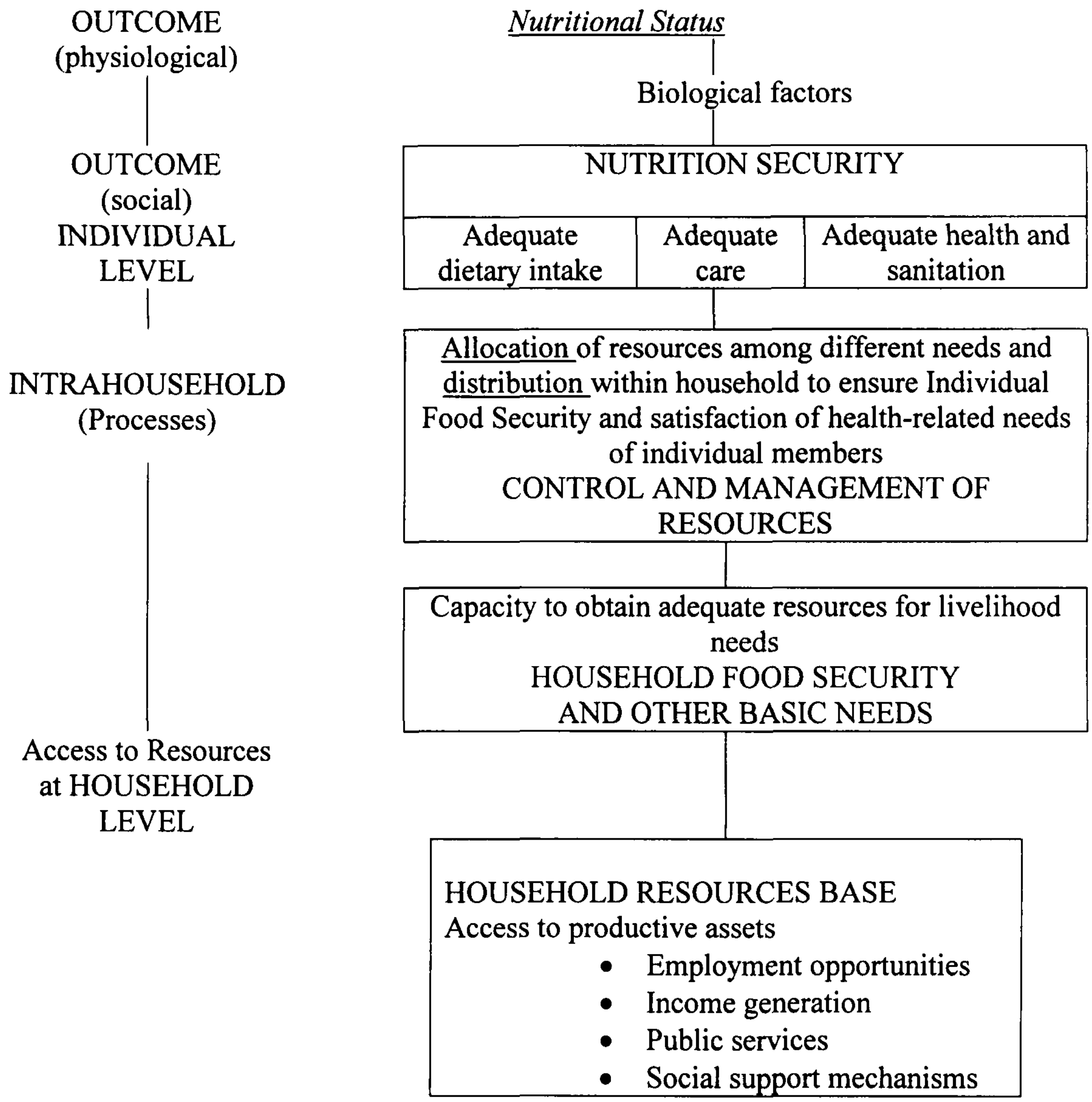
Swaminathan (1996) draw up a balance sheet for population's food and nutrition security, recognizing three major phases: food self-sufficiency, food security, and nutritional security. Food self-sufficiency has become a statistical concept for measuring the quantitative adequacy of food available in the market within a country. Quantitative adequacy can come from homegrown food or from food imported on commercial or concessional terms, or both. A nation is self-sufficient in food when food is readily available in the market places. Those countries that have achieved quantitative self-sufficiency in domestic food supply entirely because of homegrown food, or that have the economic ability to purchase food in the international market, can be described as having achieved self-reliance in achieving food self-sufficiency. Swaminathan further describes food security as physical and economic access to food by all people at all times. Thus, it involves concurrent steps in production and distribution. Countries that have achieved self-sufficiency should work vigorously toward attaining food security. That will involve efforts to generate adequate purchasing power for all sections of the population. "Nutrition security can be defined as physical and economic access to balanced nutrition and clean drinking water by all people at all times" (Swaminathan, 1986). Only when a country has achieved nutrition security for every child and adult to express his or her innate genetic potential for physical and mental development. Thus, the concept of nutritional security integrates genetic concerns with FAO's food security goal (Swaminathan, 1996).

Berck and Bigman 1990, defined food security as availability of enough food in order to sustain life and good health of all the world population at all times, across all countries and regions, across all income group, and across all members of individual households. They (Berck and Bigman, 1990), summerized their definition into following in order to capture all these dimensions. Food security requires the supply of an adequate amount of food so as to meet the nutritional needs of all the people at all times.

In this definition "nutritional needs" are to be determined by dietary requirements necessary to sustain a healthy and productive life and not by the effective demand and the purchasing power. "All of the people" requires catering to the special needs of weaker segments of the society and, in particular, of women and children. "At all times" emphasizes the need to prevent temporary food deficiencies as well as the long term obligation to increase food production in order to keep pace with the population growth.

Farnkenberger (1993) presented nutritional status of household and factors that are affecting it as follows (Figure 1):

Figure 1: Nutrition Security



Source: Frankenberger et al. 1993.

According to Frankenberger (1993), nutritional status of a household is affected by household resources base, capacity to obtain adequate resource base, capacity to obtain adequate resources for livelihood needs, control and management of resources within the household and nutritional security which itself is affected by adequate dietary intake, adequate care, and adequate health and sanitation.

A draft document of the sub-committee on Nutrition (United Nations, 1987) defines household food security as follows:

A household is food secure when it has access to the food needed for a healthy life for all its member (adequate in terms of quality, safety and culturally acceptable) and when it is not at undue risk of losing such access".

A wider definition of food security incorporates what is often referred in the quality of life indicators. Accordingly, food security implies livelihood security at the level of each household and all members within, and involves ensuring both physical and economic access to balanced diet, safe drinking water, environmental sanitation, primary education and basic health care. It is visualized that:

- Food security involves economic growth, especially access to resources.
- Food security touches on education especially education of women.
- Food security involves population programs; improved nutrition means lowered birth rates and increased child survival.
- Food security involves the natural environment.
- Food security is an issue of democracy.
- Participation and accountability are the natural antidotes to starvation and malnutrition of food (George, 1999).

Three non-governmental organization network handling food aid has enlarged the World Bank definition as follows (FAO, 1995):

Access .... to ... food

Availability of food is necessary, but not sufficient, condition for ending hunger. People required assured access to food. The route to that access may consist of income or work opportunities or the ability to acquire food through production, exchange or social entitlement programs.

... By all people.

Food security at the national or regional level does not necessarily indicate food security at the local or personal level. Often there is great disparity in food security among regions, communities, households and individuals.

... At all times

A food-secure world requires a peaceful and stable environment. Civil and external conflicts as well as natural disasters seriously disrupt food production. Orderly marketing and stewardship of food reserves.

... Enough ...... For an active and healthy life.

Food security means that individuals and households have access to sufficient food both in quantity and quality to meet their nutritional requirements. However, adequate food supply is not the only condition for ensuring an active and healthy life, and unless there is access to proper health care, water supply and other basic services, the food will not be efficiently used.

Von Braun, 1992, defined food security as access by all people at all times to the food required for a healthy life. He also mentioned that accesses to the needed food is necessary, but not sufficient condition for a healthy life. A number of other factors such as the health and sanitation environment and household or public capacity to care the vulnerable members of society also come into play.

U.S. Agency for International Development defined food security as when all people at all times have both physical and economic access to sufficient food to meet their dietary needs for productive and healthy life (USAID 1992). By this definition, food security is a broad and complex concept that is determined by agro physical, socio economic, and biological factors (Campbell 1991; Von Braun et al. 1992). Furthermore, food security is defined by a trial of concepts: food availability, food access and food utilization. By implication, the food insecure have lost, or at risk of losing, availability of or access to food or ability to utilize it. A few however, have broadened the notion of food security to include elements of social acceptability (Radiomer, Olson, Campbell 1989; Kendall, Olson, and Frongillo 1995) and sustainability (Chambers 1991).

Some organizations have included the concepts like reliability, autonomy and equity in their definition of food security.

A reliable food system continues to supply adequate food during seasonal and cyclical variations of climatic and socio-economic conditions. It is resilient enough to withstand the impact of exogenous shocks such as natural disasters or socially induced one. Reliable access to food may be jeopardized by natural disasters such as droughts, and also by man-made ones such as armed conflicts, a sharp fall in commodity prices, big fluctuations in foreign exchange rates, loss of a major market or imposition of an economic embargo. Reliability is distinguished from sustainability by the shorter time horizon being considered. The former deals with seasons, years and decades, while the latter has to consider impacts over longer periods (South Center, 1997).

The autonomy or self-reliance dimension of food security tends to be down played in international discussions. Like love and liberty, autonomy and self-reliance are primarily qualitative concepts, which does not make them any less important. These concepts deal basically with power relationships between countries and among social groups. At national levels, autonomy means that nation states are not subject to the dictates of other nations, or transnational organizations, in which they have no effective voice in determining the policies and rules affecting their food systems. Greater national food self-sufficiency can often contribute to increased autonomy, but it is only one factor among many (South Center, 1997).

Equity concept deals with how to assure that every social group and individual has access to adequate food at all times is the central issue for any discussion of food security (South Center, 1997).

Serageldin (2000) considered food security as a complex issue that involves: not just production, but also access, not just output, but also process, not just technology, but also policy, not global but also national, not just national but also household, not just rural but also urban, not just amount but also content.

United States Department of Agriculture (USDA, 2000) suggested following definition for food security. Food security exist when all people at all times have physical and economic access to sufficient food to meet their needs for a productive and healthy life.

Timmer, 2000, defined food security as an environment in which the lowest income quintile has a near zero probability of being vulnerable to famine.

Rome declaration on world food security and World Food Summit plan of action, 1996, which has been hailed by most of the countries around the world has defined food security as when all people at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (FAO, 1996). According to Gulati (2000) what is this definition of food security means is at least five things:

a) That food security is as much as a matter of physical access to food as it is of economic access or entitlement to food.

b) That food security relates to all the people, irrespective of their income levels, age, education, gender, etc.

c) That food should be available to them at all times, be it period of war, civil strike, or any natural calamity.

d) That food should be available in sufficient quantities, preferably in line with the consumption preference of the people.

e) That food has to be safe and nutritious that leads to a healthy life.

FAO (2001) defined food security as access by all people at all times to enough nutritionally adequate and safe food (quality, quantity and variety) for an active and healthy life. In this way creation of the conditions in which all people can secure the food they need and be well nourished in dignified and sustainable way is must. According to this definition food security is based on three pillars:

- Food must be available, meaning that adequate amounts of good-quality, safe food must be produced or imported at the national and local levels.
- Food must be accessible, meaning that it must be distributed and available locally, and it must be affordable to all people.
- And finally, food must be used in the best possible way for each person to be healthy and well nourished (sufficient in quantity and variety for each individual needs.

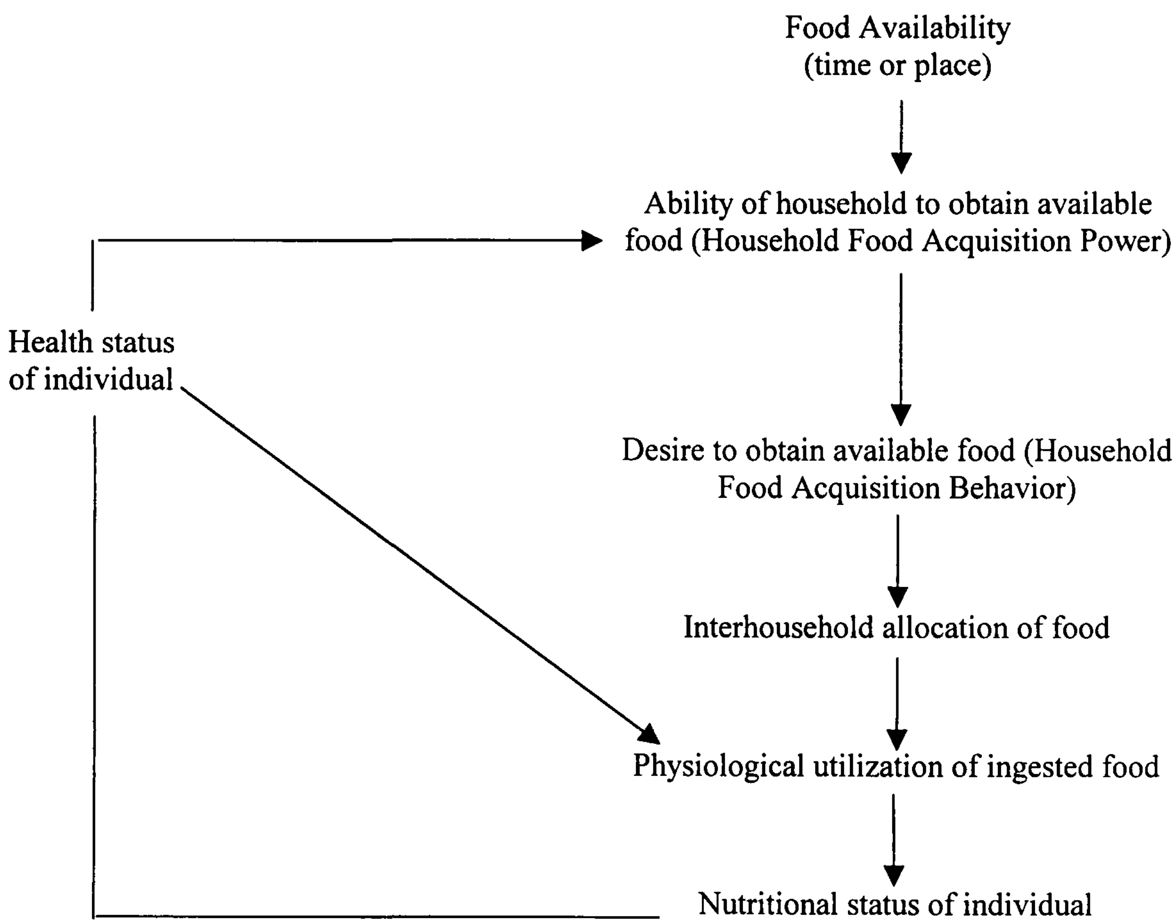
Alamgir et al. 1991 linked Food security with food intake at the individual level and food availability at other levels, e.g., household, sub-national and national. They further defined a food secure household as one, which has enough food available to ensure a minimum necessary intake by all members.

For a household, availability depends on many variables. These include net food production, land, labor, capital, knowledge and technology and social production relations; food prices, food supply in the market, cash flow from rent Income, wages, profits from enterprises or sale of assets, debts and other liabilities; net stock, and net receipts in kind from government, wages in kind, gifts, credit and transfers from government and other internal and external donors. Clearly, an adverse movement in any one or more of these variables will adversely affect the food security of a household

(Alamgir, et al, 1991). If such adverse movement are temporary and household copping strategies fail, there exists a case of transitory food insecurity (WFP, 1990). On the other hand, if movements stem from structural problems and continue over a long period, then the situation can be characterized as one of chronic food security (Reutlinger and Von Hoast Pellekaan, 1986).

The key factors affecting household Food security and individual Nutritional Status are shown in the Figure 2:

Figure 2: Factors Affecting Household Food Security.



Source: Per Pinstrup - Andersen, 1981.

Thus, as shown in Figure 2, the household food status is affected by the availability of food, the ability and desire of the household to acquire it, its intra household distribution, and the physiological utilization of the ingested nutrients, which both affects and is affected by the person's state of health. The person nutritional status also has a feed back effect on their productivity, and the ability to acquire food (Senauer and Roe, 1997).

A household may drive its food entitlements from different sources including:

- Own production,
- Income (from the sale of labor or of surpluses)
- Disposal/Use of assets.

When households are able to generate a surplus above their basic food requirements, the excess resources are diverted into assets, from which the household can draw in the event of a food crisis. Assets can be either physical or human, or merely in the form of social and institutional claims (IFAD, 1992).

International Fund for Agricultural Development has summarized the factors, which are affecting household food security in table form.

Box 2: Causes Shaping Household Food Security.

Concept	Source	Variables
Food access	Food Supply	Per capita staple food production Staple food yields Duration of staple food harvest
	Income	Total income
	Assets	Land sale Live stock sales Durable good sales
	Access to credit	Amount borrowed
	Access to natural resources	Gathering of wild fruits and plants
	Claim/social network	Transfer, remittances, subsidies, gifts, access to informal credit
Security/risk	Diversification	Income composition Number of crops grown by the household
		Number of crops grown in the community
		Income-generating activities in petty trading
		Number of household members working off farm
	Food market integration	Staple food market dependency ratio Net staple food purchases
	Migration	Male head migration Female head migration
	Assets	Asset stock Asset liquidity Asset depletion

Source: IFAD, 1992.

Dimensions of Food Security:

The job of reducing hunger involves (a) adequate global food supplies to meet the demand of growing world population; (b) reducing poverty to allow people to buy or produce the food they require; and (c) health and nutrition programs, including nutrition education.

Ensuring food security for all is a challenge with many dimensions. These are outlined in matrix 2. In the short run, reducing hunger must focus at the household level with enabling actions by nations. Globally, only adequate supplies and food aid can help. In the medium-term, the emphasis must be more at national and international levels, focusing on reducing poverty and generating sustained economic development for all. Central to that vision are concerted national and international efforts to generate appropriate agriculture technology to improve the productivity and profitability of millions of farmers in developing countries. in the long-term, global food supplies must increase in sustainable production systems, moreover a fare trading system is vital.

Box 3: The Dimensions of Food Security: Critical Variables.

	Short Term (1-3 Years)	**Medium-Term (5-15 Years)**	**Long-Term (25-30 Years)**
Household	Access to Food Nutrition and Health	Access to Income Or Means to produce food	Poverty Eliminated Social infrastructure
National	Safety Nets Nutrition and Health	Economic development Sustainable production Systems Agricultural Research	Rural and economic development Sustainable production systems Agricultural research
Global	Grain Stocks Food Aid	International Research Fair Trading System Sustainable Global Supplies	International research Fair trading systems Sustainable global supplies

Source: World Bank, 1996.

Definition of Food Insecurity:

Food Insecurity is defined as limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways (Life Sciences Research Office, Federation of American Societies for Experimental Biology, 1990).

Food Insecurity exists whenever the availability of nutritionally adequate, safe foods, or the ability to acquire personally acceptable foods in socially acceptable ways, is limited or uncertain for a person (Campbell, 1990).

Food Insecurity is the lack of access to enough food. There are two kinds of food insecurity: Chronic and transitory. Chronic food insecurity is a continuously inadequate diet caused by the inability to acquire food. It affects households that persistently lack the ability either to buy enough food or to produce their own. Transitory food insecurity is a temporary decline in a household's access to enough food. It results from instability in food prices, food production, or household incomes and in its worst form it produces famine (Reutlinger and van Holst Pellekann, 1986).

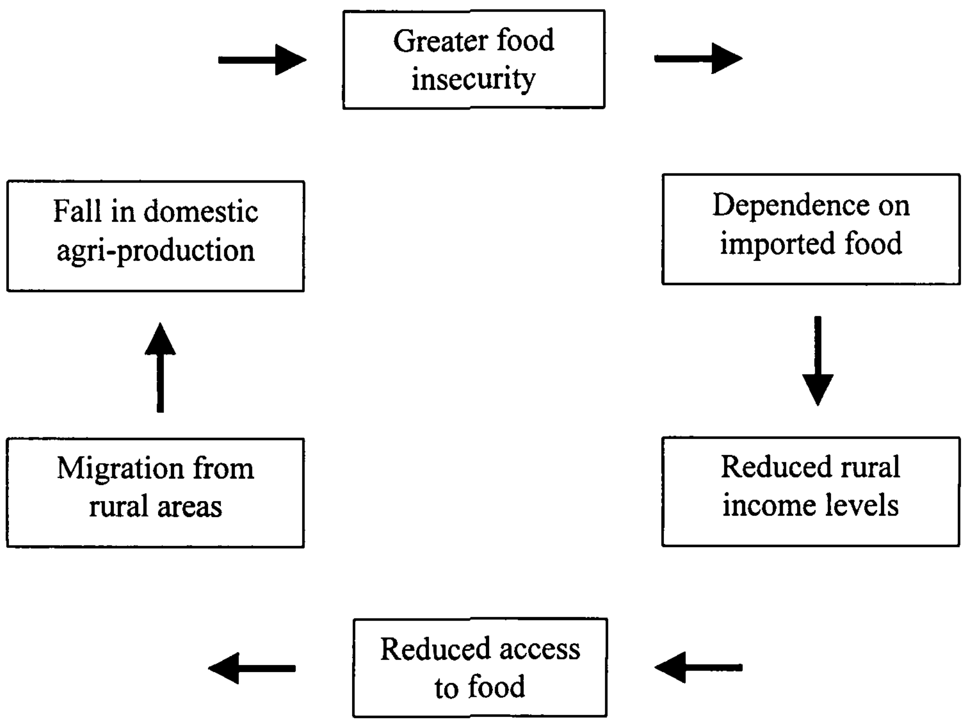
FAO in a document published in 2001 (Feeding Minds Fighting Hunger) listed three major causes of food insecurity these are;

1. Constraints on access to food and continuing inadequacy of household and national incomes to purchase food.
2. Instability of supply and demand and;

3. Human made disasters.

International Food Policy Research Institute (IFPRI) in Proceeding of its International Conference on Sustainable Food Security held in September 2001 in Bonn Germany described the cycle of food insecurity as following:

Figure 3: The Cycle of Food Insecurity



Source: IFPRI, 2002

Principal Consequences of Food Insecurity:

Food insecurity and the frequently extreme efforts made by affected to avert it lead to much human suffering. In addition food insecurity results in substantial productivity losses in both the short and long run because of reduced work performance, lowered cognitive ability and school performance, and inefficient or ineffective income earning decisions designed to hedge against food availability and access constraints. Food insecurity can thus lead to misallocation of scarce resources and loss through sale of productive assets. Food is essential to survive, and people are more emotionally secure and better off psychologically when they have food security. food security and adequate nutrition are beneficial outcomes in themselves as well as important inputs to economic development.

Improved adult nutrition leads to higher productivity in the labor market. High levels of morbidity, due in part to insufficient nutrition intake, can reduce work time directly as well as indirectly through the need to take care of sick family members. High levels of morbidity can also divert household resources away from farm or non-farm investments toward medical care.

Cognitive development and school performance are impaired by poor nutrition and health, with consequence losses in productivity during adulthood. Poor nutrition and health in early childhood can have long-term consequences that affect a child's later progress in school. Among school age children, nutritional deficiencies are responsible in part for poor school enrollment, absenteeism, early dropping out, and poor classroom performance. Educators have often overlooked the significant improvements in school performances that can result from nutrition and health intervention (Politt, 1990).

Not only does food insecurity have deleterious effects on households and individuals, but the effort to achieve food security may also exact a heavy toll from households if , for example it involves their spending most of their income on obtaining food, leaving little for basic necessities of life such as housing and health. Households may achieved temporary food security at the cost of substantial asset disposal and future indebtedness, thus digging themselves deeper into the mire of poverty. In extreme case, a household that uses almost all of its resources to achieve food security in the present renders itself highly vulnerable to food insecurity in the future.

The efforts of food insecure households to acquire food may also have important implications for the environment and the use of natural resources. Many poor and food insecure households live in ecologically vulnerable areas (Leonard and Contributors, 1989), and inappropriate desperate land use practices can cause environmental degradation that can further undermine their livelihood.

The food insecure and the poor often have to choose between short-term satisfaction of food needs with long-term environmental degradation and short-term hunger with long-term environmental conservation.

The search for food security may also have important implications for a region's demographic situation, especially if it leads to short-term migration to other areas in search of employment and income or, in the extreme case, in search of relief food, such out migration may result in an increased number of female headed households, a higher dependency ratio in the sending area, and change in the dynamics of the labor market. The receiving areas, mostly urban slums, experience considerable food security strain from the influx of migrants.

Definitions of Malnutrition:

Malnutrition or undernutrition is the physical state resulting from inadequate food intake for long periods of time. Most of the effects of malnutrition, particularly in the Third World and even in developed countries, are well known and relatively easy to measure.

Such effects include low birth weight, impaired growth, high infant mortality, anemia, and other specific nutrient deficiencies. However, hunger does not always lead to clinical malnutrition (Margen, 1989).

Malnutrition is a broad term indicating impairment to physical and/or mental health resulting from failure to meet nutrient requirements. The insufficiency of nutrients may result from inadequate nutrient intake or form interference with the body's ability to process and utilize nutrients. Malnutrition is most often clinically observed as stunting, tissue wasting, cognitive and behavioral deficits, or, in extreme form, a disease of starvation (e.g., Kwashiorkor, Marasmus) (Physician Task Force on Hunger in America, 1985).

An outgrowth of hunger is malnutrition, a condition in which the body does not obtain a sufficient supply of the essential nutrients. Even people who do not generally experience hunger can be malnourished if they do not have balanced diets (Leinwand, 1985).

Malnutrition is a state of poor health with symptoms that can be identified clinically as due to inadequate intake of one or more essential nutrients over a sustained period, it includes both under-nutrition and over-nutrition (Massachusetts Department of Public Health, 1983).

Malnutrition is defined as any disorder of nutrition including deficiencies, excesses, or imbalances in the intake of nutrients (Kennedy and Andersen, 1983).

Food and Agriculture Organization's (FAO's) Fifth World Survey provides a useful perspective on the problem (hunger). It notes first that, whereas hunger in the strict sense refers to undernutrition, that is, inadequate intake of calories for the size and activity level of the individual concerned, individuals may also suffer from a food problem if they lack certain essential nutrients, that is, if they are malnourished. For convenience, The World Food Survey thereafter uses the terms malnourishment and malnourished broadly, to cover both lack of calories and lack of nutrients. The hungry, then, are those who are malnourished in one way or another (Clay & Show, 1987).

Starvation is an extreme form of hunger. The underlying problem is chronic malnutrition the lack of enough calories and nutrients to sustain normal growth, health and activity (Simon, 1987).

Malnutrition is the situation in which the body is lacking the raw materials from food to function properly. If denied food for long periods of time, physiological and physical changes occur. Both unbalanced and inadequate diets can lead to malnutrition. People can be malnourished and appear healthy as is sometimes the case with anemia (lack of iron). They may look overweight as in obesity, or underweight as in starvation. They may be stunted for their age, one result of malnutrition during childhood, or be born with congenital problems, one result of poor diet during pregnancy (Food Research and Action Centre, 1983).

Malnutrition is a condition that results from an excess, imbalance, or deficit of nutrient availability in relation to tissue needs (Dietz and Trowbridge, 1990).

Malnutrition is generally defined as some measurable degree of ill health due to inadequate nutrition that can be prevented or cured by improved nutrition. With some 50 different nutrients there can be at least 50 different types of malnutrition. If some of these nutrients function in relation to each other, as most of them do, there can be many more than 50 types of malnutrition (Rosenfield and Stare, 1969).

Malnutrition is a pathological state, general or specific, resulting from a relative or absolute deficiency or an excess in the diet of one or more essential nutrients. It may be clinically manifest or detectable only by biochemical and physiological tests. Five different forms of malnutrition have been distinguished: starvation, undernutrition, specific deficiency, imbalance, and overnutrition; some writers do not consider overnutrition and its resulting obesity under the heading of malnutrition (FAO, 1987).

Definition of Hunger:

Hunger may be defined as “a condition resulting from chronic under-consumption of food and/or nutritious food products”. It may be precipitated by an inability to obtain sufficient quantities of food to eat or a failure to consume adequate quantities of nutritious food products, regardless of the ability to obtain sufficient food supplies (Lenhart and Read, 1989).

Hunger as commonly defined means not just symptoms that can be diagnosed by a physician, it bespeaks the existence of a social, not a medical problem: a situation in which someone cannot obtain an adequate amount of food, even if the shortage is not prolonged enough to cause health problems (The United States President's Task Force on Food Assistance, 1984).

Hunger is the uneasy or painful sensation caused by lack of food. The recurrent and involuntary lack of access to food. Hunger may produce malnutrition over time. Hunger, as the recurrent and involuntary lack of access to food that may produce malnutrition over time, is referred to as "consequences of food insecurity" (Life Sciences Research Office, Federation of American Societies for Experimental Biology, 1990).

In 1988, the American Institute of Nutrition and the American Society of Clinical Nutrition initiated a joint Task Force on Hunger and Malnutrition. This task force defined hunger as follows:

Hunger is a recurrent, involuntary lack of access to food. Hunger may produce malnutrition over time (Dietz and Trowbridge, 1990).

Hunger is defined as the physiological manifestations of acute, current food shortage such as that which occurs when a child is deprived of a meal (Allen, 1990).

Community Childhood Hunger Identification Project (CCHIP) defines hunger as the mental and physical condition that comes from not eating enough food due to insufficient economic, family, or community resources. The measurement of hunger developed by CCHIP attempts to detect food insufficiency due to constrained resources. The CCHIP survey measures insecurity about having the resources to procure foods of choice, perceived insufficiency of food intake, actual food shortages, and alteration of eating behaviors due to restricted or inadequate resources (CCHIP, 1991).

The definition proposed by Cohen and Burt looks at hunger as a process. It is not one discrete event, but a sequence of events that leads up to and follows a lack of adequate food intake. It is the process in which people become at risk of hunger, attempt to cope with the problem, and suffer a variety of health and social consequences. The specific definition is "the state of being unable to obtain a nutritionally adequate diet from non-emergency food channels (Cohen, 1990).

Hunger is the inability to acquire or consume an adequate quality or sufficient quantity of food in socially acceptable ways, or the uncertainty of being able to do so (Olson and Campbell, 1990).

It is generally agreed that hunger is the state of being unable to obtain enough food to satisfy the minimum requirements of a nutritionally adequate diet. However, from a policy standpoint, hunger is the result of a process in which people become at risk of hunger, attempt to cope with the problem and suffer a variety of health and social consequences (Cohen and Burt, 1989).

Hunger, simply defined, as a craving for food. From time to time all of us have had a craving for food, and to that extent we have experienced hunger. However, hunger, as used here, is a chronic condition in which people are forced to go for days without a full meal. People who are chronically hungry may try to ease their craving for food by filling their stomachs with thin soups, stale bread, or cereals, or with whatever else they can find (Leinwand, 1985).

It is not easy to look at hunger in perspective. Even defining "hunger" raises debate, since it is clearly a condition of degree. It may be a craving for food, a weakened condition from a lack of nourishment, or a yearning stemming from a self-denial, such as a diet or fast.

The effects of hunger, then range from temporary discomfort to death. The Citizen's Board of Inquiry into Hunger and Malnutrition in the United States (CBHM) defined hunger as "a condition where people are forced to go days each month without one full meal". Although still somewhat arbitrary, the definition does allow for measurement. Perhaps equally essential for a workable policy definition of the hunger problem, it contains the element of force, and it incorporates (through frequency) the concept of degree (US Department of Agriculture, 1978).

Experiencing Food Insecurity; Interviews with Food Insecure People:

International Food Policy Research Institute (IFPRI), in a 1997 document entitled "Identifying the food insecure; the application of mixed-method approaches in India", have used both qualitative and quantitative indicators to identify food insecure people in rural areas. Qualitative indicators are developed on the basis of interview with some of these people.

I. I Have Buried Eight Sons:

Old age lack of family support makes it difficult for elderly households to cope. In addition a change in household demographics can make a significant change in the food security of those living on margin.

When Kavali Mogulanna and his wife, Hanumamma, were first interviewed, they were living alone. Mogulanna was 78 years old, and his wife was 65. He had stopped working in previous year, but Hanumamma continued to do wage work when she could get it. Mogulanna had become so old that he could not even bathe himself anymore. Nevertheless he reported, "My only problem is age; otherwise I am Healthy"

Throughout his life, Mogulanna worked on and off as an attached laborer. Together he and Hanumamma had nine children "I have buried eight sons", she said, and described how seven of the children died before age of five. Two live d past their childhood years. Their one remaining child, a daughter, lived in the same village and was also poor. Hanumamma explained that her daughter sometimes sent them food; six months before, they had received one-quarter kilo of red gram *dhal.*

Years earlier, Mogulanna had inherited 3.7 acres of land from his father, but the family was forced to sell it to pay debts from the marriage of their one son who survived childhood. Their single asset was a baby buffalo, given to them by Hanumamma's brother. Hanmamma explained why she wanted to sell it. "I am finding it difficult to take care of this animal. It needs a lot of food and water, which I can't provide, I have become very old and don't have the energy to look after it."

In her old age, Hanumamma still did paddy harvesting so that she would earn in-kind wages. She was unhappy to admit that many people did not want to hire her anymore because she was not quick and efficient; in addition, her vision was bad. After returning from the fields one day, Hanumamma said she was so tired that she could not pound the paddy she earned for dinner. There was no cooked food in the house, so the two went to sleep without eating. "I will tie my stomach with a cloth and go to sleep", she explained. She had done this many times so that she would not feel hungry.

Aside from occasional harvesting jobs, Hanumamma sometimes worked as a sweeper in a wealthy landlord's house. The couple also received Rs 90 every three months as an old age pension from the government. But this was hardly enough to survive; most of it went right away to pay small debts from shopkeeper and neighbors.

II. My Body has Habit of Work, So It is Still Working:

Sometimes an elderly widow's only resource is her two hands. Malanbai, an old widow, attributed her downfall to old age; joblessness, loss of a working son, and the lack of social support.

During the sever drought of 1972, her family ate wild weeds to survive. Nevertheless, she lost her husband and four children. Only one son and daughter remained. Soon after their deaths, her brother in law drove her family out of their house. Malanbai lived with her son and worked to survive; she earned 75 Paise a day 9roughly 2 cents). Her son was good to her, but he died young after he stepped on a nail and contracted tetanus. Her daughter in law left with her grandchild, who died soon after. A short time later, her brother in law insisted that she repay Rs 1500, which he said her husband had borrowed from him. The village *Panchayat*, whom she linked to God, supported this demand.

It took her four years to pay off the loan, and she remained extremely poor. She never borrowed money and did not run credit at any shops. When she did not have money, she ate *roti* with Chile powder or *Kanya* (sorghum gruel) without sugar or salt. When she had money, she bought a small quantity of cheap vegetables (like eggplant) or low quality *dhal*. "I don't even look at potatoes and tomatoes', she commented. Her method of copping with poverty is matter of fact. "I don't dare ask anybody for money. If I cannot get anything to eat. I drink lots of water and go to bed hungry".

Even in her elderly state, Malanbai was still considered one of the best wageworkers in the village. She worked hard and was honest. Employers often sought her when they needed workers.

Malanbai knew that her ability to work was her only asset. Fearing that she would be helpless if she became sick, she considered selling the half-acre of dry land that she still owned. As soon as her son in law and brother in law heard, they wanted their share. For the time being, Malanbai gave up the idea of selling her land.

III. We have to Borrow Money for the First Time in our Lives. We are Finished:

Unexpected accident can send a relatively food secure family into debt and food insecurity. Archana and Vinod Manohar lived in an abandoned, dilapidated house. Vinod Manohar typically worked on a sand carting truck and farmed some of his own land.

Then Vinod Manohar had an accident when riding his bicycle and hurt his hand and head. Until the accident, the family had done quite well. Vinod Manohar was an only son and had inherited two acres of dry land. He was a careful farmer and improved the land by manuring. He and his wife got yields and were able to save their money because they had no children for several years. They bought a cow and fed it well; it produced two liters of milk a day. Together Vinod Manohar and Archana worked and earned about Rs. 390 per week (Approximately US$ 13). "We were earning well, and our expenses were minimal". He said. During this time they had no debts. They did so well they could afford to spend nearly 10000 on pilgrimage and rituals so that they could have a child.

Their plans were dashed with the accident. For the initial check-up, they borrowed Rs 500, and the doctor estimated they would need Rs 2000 more. They had no saving; recently they had spent Rs 4000 on two acres of land. " Now we have to borrow money for the first time in our lives. We are finished".

Archana said they still had one bag of sorghum. They ate one bag of hybrid *jowar* (Sorghum) because it was cheap and prone to pest infestation. Their bag of local *Jowar* could be stored for two years and would be useful during the rainy season. They were also planning to buy wheat and rice so that the remaining stock of *Jowar* would last them until the next harvest.

IV. Even a Sinking Person would Try to Hang on a Small Stick:

Landlessness, debt, unexpected sickness, and social obligations work together to create a situation of food insecurity.

Nandishilor's family had always been poor, so poor that when it came for him to seek a bride, no one was willing to make an alliance with him. Once, while in pune, he met Vimal. She was also very poor. Because they were both poor and unmarriageable, they decided to marry each other. They live in Shirapur in a two rooms house obtained from the Indira Gandhi Program. At first Nandishilor worked on a sand carting truck, and Vimal did not work. Then Nandishilor became sick and need e intravenous drip. They owned no land, so Vimal borrowed Rs. 500 by offering the tin sheet from her roof as collateral. The moneylender demanded that she give him the sheets; rather than live without a roof, she sold her *Mangal Sutra* (marriage necklace).

With interest, the debt became bigger and bigger, and lenders started troubling them. Nandishilor was finally forced to accept work as an attached laborer to pay his debts. He received a lump sum of Rs. 500 and was given 28 kilos of sorghum per month. The large debt was paid off. But they were forced to take small loans because their in kind earnings were not enough to make ends meet. To supplement their income, Vimal raised a couple of hens to buy *mit-mirchi* (daily groceries). The children demanded the food they were once accustomed to eating, but Vimal could not provide it. They both saw their children had lost weight.

Indicators of Food Security:

With the study of narratives of food insecure people, it is easily seen that most of household food security indicators are linked to the poverty issue (also see George 1999). As Sen (1981) points out, the poor do not have adequate means or entitlements to secure their access to food, even when food is available in local or regional markets. Hendry (1991) points out that while there is irrefutable evidence that poverty is the most evident common denominator among nations, communities or households afflicted by chronic undernourishment, it is not the sole determinant. The extents to access to gainful employment, to arable land, to suitable technologies, and to other productive resources are important factors influencing under nutrition.

The factors that influence the food security status of households and individuals may be quite diverse. The US Agency for International Development (USAID) identifies a range of important factors that lead to food insecurity of households and individuals in the developing world. These factors include chronic poverty, rapid population growth, declining per capita food output, poor infrastructure, ecological constraints, limited arable land, disease, poor water and sanitation, inadequate nutritional knowledge, civil war, and ethnic conflicts (USAID 1995).

As a result of diversity of factors that have direct as well as indirect effects on food security, there are different indications of food security also. One volume on household food security by Maxwell and Frankenberger (1992) lists 25 broadly defined indicators. Riely and Moack (1995) lists 73 such indicators, somewhat more disaggregated than those found in Maxwell and Frankenberger. Chung et al. (1997) note that even a simple indicator such as a dependency ratio can come with many different permutations. They (Maxwell and Frankenberger) list some 450 indicators. In their work Maxwell and Frankenberger, a distinction is made between process indicators (those describe food supply and food access) and outcome indicators that describe food consumption. Process indicators are insufficient to characterize food security outcomes (Hodintt, 1999); Chung et al. (1997) found that there is little correlation between process indicators and outcomes indicators.

Von Braun et al. (1992) have suggested the following indicators to capture the various dimensions at the country, household and individual levels.

- Food security at the country level can be monitored, to some extent, in terms of demand and supply indicators.
- Food security of the household level is best measured by direct survey of dietary intake.
- Anthropometrics information can be useful to represent individual level measures.

Chung et al. 1997 has summarized the diverse determinants (indicators) of food security status in a general conceptual framework (Fig. 4).

Figure 4: A Conceptual Framework of Food Security and Generic Indicator Categories.

Food availability		**Food access**		**Food utilization**
Resources	Production	Income	Consumption	Nutrition
*Natural	*Farm	*Farm	*Food	*Child
*Physical	*Non Farm	*Non Farm	*Non Food	*Adult
*Human				

Resources	**Production**	**Income**	**Consumption**
Natural	Total area cultivated	Total income	Total expenditure
Rainfall levels	Irrigated area	Crop income	Food expenditure
Stability	Area in fallow	Livestock income	Non-food expenditure
Soil quality	Access to and use of input	Wage income	Consumer prices
Water availability	Number of cropping seasons	Self-employment income	Dietary intake
Forest resources access	Crop diversity	Producer prices	Food frequency
Physical	Crop yields	Market, road access	
Livestock ownership	Food production	Migrant income	
Infrastructure access	Cash crop production		
Farm implement ownership	Number of sources of non-farm income		
Land ownership, access to other physical assets	Cottage industry production		
Human			
Gender of household head dependency ratio Education, literacy level, household size, age of household head			

Source: Chung et al 1997.

They (Chung et al.) have used the following indicators to household food insecurity based on triangulation among various qualitative methods.

- Owning poor quality land or no land.
- Holding distress sales of large livestock or small livestock.

- Holding distress sales of other productive assets.
- Holding distress sales of other valued assets such as jewellery.
- Taking out a high number of small loans, especially from informal sources (neighbors, relatives, and shopkeepers).
- Chasing drought-tolerant crops when profitable but risky options exist.
- Relying heavily on wage work.
- Accepting attached laborer positions.
- Women who work for wage and have young children.
- Migrating in search of work.
- Having few income earners in a large family.
- Purchasing staple grains more than once a week.
- Suffering from physical disabilities, or chronic illness.
- Substituting inferior quality staple foods for preferred quality.
- Substituting inferior quality vegetables or legumes, or going without.
- Substituting gruels for the main staple (to stretch consumption).
- Providing dowries.
- Buying gifts and fulfilling obligations to relatives.
- Celebrating religious holidays.

Who are the Food Insecure People?

Depending on factors such as agro-ecological characteristics, access to land, diversity of income source, and state of development of the economy, food-insecure households can be members of different socio-economic and demographic groups in different areas. Nevertheless, some common characteristics of food insecure people emerge, of which poverty is a central one. The poor face the most severe constraints in their own food production and in their access to food from markets (Von Braun et al, 1992). Ironically almost three-quarters of the poor and hungry are rural people living in places where food is grown. These people including the landless, those living in poor nations, or living in areas with poor agricultural potential or which are environmentally fragile. The remaining one-quarter of poor are underemployed, urban unemployed dwellers, who live on less than a dollar a day[1] (World Bank, 1996).

Several researchers have included the concept of vulnerability in their definition of food security (Watts and Bohle 1993; Radimer, Olson, and Campbell 1990, Kendall, Olson, and Frongillo 1995). Accordingly, the people who are vulnerable to food insecurity may include:

Internally displaced people

- Refugees
- Landless returnees
- Landmine disabled
- War invalids
- War widows and orphans

[1] In its International Conference on Sustainable Food Security, International Food Policy Research Institute using a digital instant voting system asked from conference participants the following question, "where do we find more food insecurity and poverty today?" While 72% of participants answer was in rural areas, 13 9% & 11 7% of answer was in urban sector and equally in both sectors respectively and 2 4% of participants had no opinion about the question

Migrant workers and their families:

- Migrant herders tending other people's herds.
- Migrant laborers seeking seasonal work.
- Female-headed households left behind by migrant male laborers.

Marginal populations in urban areas:

- Unemployed people.
- Rickshaw and motorcycle taxi drivers.
- Recently arrived migrants.
- People living in slums on city outskirts.
- Dock workers and porters and construction workers.
- Workers in the informal sector.
- Homeless people.
- Orphans.
- Street children and people living alone on small fixed incomes or without support.
- Beggars.

People belonging to at risk social groups.

- Indigenous people.
- Ethnic minorities.
- Illiterate households.

Some or all members of low-income households within vulnerable livelihood systems.

- Subsistence or small-scale farmers.
- Female-headed farming households.

- Landless peasants.
- Agricultural labors.
- Fishers.
- Nomadic pastoralists.
- Sedentary herders, small-scale livestock producers and agro-pastaralists.
- Forest dwellers.
- Pri-urban small-scale agricultural producers and market gardeners.
- Day or contract laborers.

Dependent people living alone or low-income households with large family size.

- Elderly people.
- Women of childbearing age, especially pregnant and nursing mothers.
- Children under five years old, especially infants.
- Disabled and ill people.

Chapter 2

State of Food Security of Different Regions and Countries: Current Position and Future Challenges

Prospects for Food Demand:

Future demand for food will come from population growth and from higher incomes, the latter increases the demand for meat, vegetable, fruits and of grains for livestock feed. Meanwhile there is no scope for expanding area under cultivation.

There is considerable disagreement about how easy or difficult it will be to meet the challenges of Global Food security. Views range from "there is no problem" to "the malthusicin nightmare is imminent". This is not a new worry. Societies have long been concerned that food supplies could not grow in step with population, leading to wide-spread food shortages and famine. Malthus articulated this view in his famous essay on the principle of population as it affects the future improvement of society. Published in 1798, which argues that population grows geometrically, yet food supplies can grow only linearly. While the situation that Malthus envisioned has never materialized, concerns about imminent food shortages have continued to arise.

People were worried about global food shortages immediately after world war II, and again in 1965-66, following two bad monsoons in South Asia. Both periods were followed by years of expanded output. Then, in 1972-74, a confluence of production shortage and escalating demand, particularly from former Soviet Union, led to tripling of grain prices over an eight-month period, again giving rise to predictions of disaster. Farms responded to the price incentives, and by the early 1980s, the concept was about surplus, not shortages.

The debates continue today. On one side are the optimists who anticipate that yields in the future can continue to grow fast enough to not only feed the world's growing population, but also to contribute to future declines in the real price of food.

Among optimists are those who believe that "getting prices right" is all that is needed to ensure sufficient global food supplies: with accurate price signals, farmers will respond by planting idled average, by utilizing land under production more intensively, and by making key investments in genetic stock, irrigation, and agricultural chemicals. Other, more moderate, optimists believe the world can meet the challenge but only if governments provide adequate resources for research, health and education, and rural roads, irrigation, water and sanitation.

On the other side are pessimists who debate that the 1990s were the beginning of new era in which it will be much more difficult to expand food production. They observe that the growth in yields has perceptibly slowed, and argue that fisheries and rangelands have reached their limits of production, water supplies are nearly fully exploited, land under cultivation is rapidly becoming degraded, substantial cropland is being converted for factories, roads, and urbanization, and climate change threatens existing crop production. Meanwhile, the scale of world population growth is unprecedented, putting strains global systems unlike those ever before encountered.

Demand for food is influenced by a number of forces, including population growth and movements, income level and economic growth, human resource development, and lifestyles and preferences (Andersen and Pandya-Lorch, 2001).

Never before in human history the population of earth has been as great as it is today, and never before in the history of civilization has it grown so rapidly within one century (Table 1).

Table 1: World Population Growth by Billions

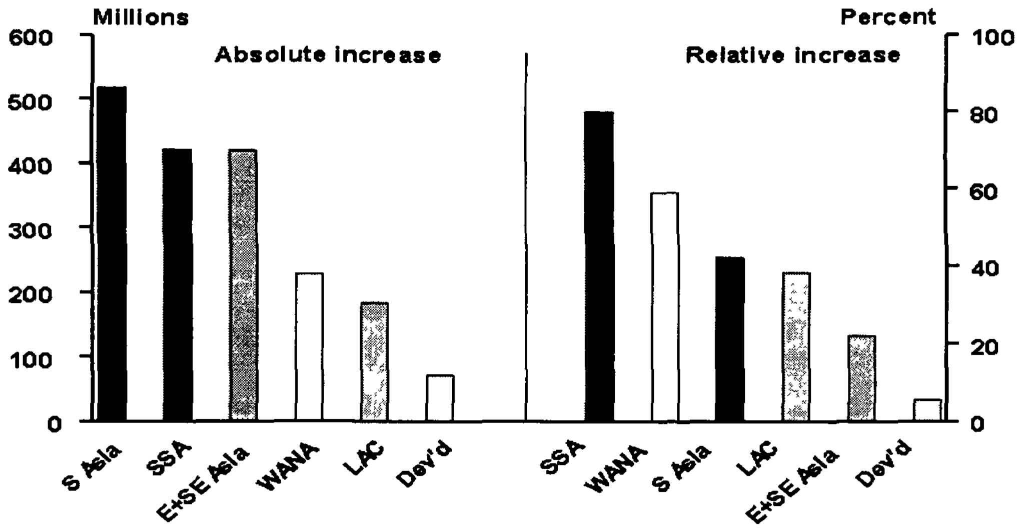
World population in billions	*Year*	*Time needed to reach this level*
One	1804	All of human history
Two	1927	123 years
Three	1960	33 years
Four	1974	14 years
Five	1987	13 years
Six	1999	12 years
Seven	2012	13 years
Eight	2026	14 years
Nine	2043	17 years

Source: United Nations Population Division; World Population prospects; the 2000 Revision, Vol. 1 (New York)

People born before 1960 are the first generation in history who will witness a doubling of the world's population in their lifetimes, while those born in or before 1927 have seen a tripling.

United Nations recently estimated about 73 million people, will be added to the world's population on average every year between 1995 and 2020, increasing it by 32 percent to reach 7.5 billion in 2020. An overwhelming 97.5 percent of the increase in population is expected to occur in developing world, whose share of global population will increase from 79 percent in 1995 to 84 percent in 2020. Whereas absolute population increase will be largest in Asia, 1.1 billion, the relative population is expected to increase by 70 percent (Figure 1).

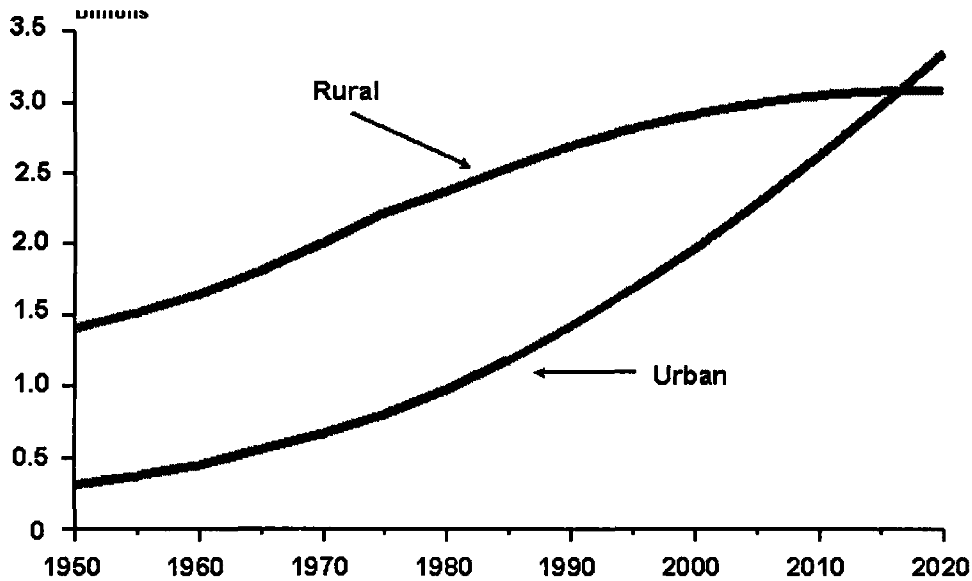
Figure 1: World Population Increase 1995 and 2020



Source: Andersen et al. 1997

Much of the population growth is expected to take place in the cities of the developing world. While its rural population is expected to increase by less than 300 million between 1995 and 2020, the urban population is projected to double from 1.7 billion to reach 3.4 billion in 2020 and by 2015 it is estimated the urban population in developing countries overtake rural population (Figure 2).

Figure 2: Urban and Rural Population in Developing Countries, 1950-2020



Source: Andersen et al., 1999.

The start of the twenty-first century marks the first time in human history that more people are living in cities and towns than in rural areas. More than half the population of Africa and Asia will be urban by 2020 more than three quarters of Latin Americans already are (Leisinger et al, 2002). Rapid urbanization undermines food security. People living in cities cannot feed themselves by subsistence farming. They must purchase most of their food. So their food security depends on what they can afford to buy. Thus food security in urban areas is inextricably linked to income security.

By 2020, about 52 percent of the developing world's population will be living in urban areas, up from 38 percent in 1995 (United Nations 1996). The rapid urbanization of developing world and associated changes in lifestyles will have significant effects on food preferences and hence on demand. As people move from rural to urban areas, they tend to adopt more diverse diets, shifting away from coarse grains such as sorghum and millet to rice, and sometimes making secondary shift from rice to wheat, they also tend to consume more livestock products, fruits , vegetable and processed food (Andersen and Pandya-Lorch, 2001).

As a result of increase in demand for livestock products a demand driven revolution which is termed as Livestock Revolution by Christopher Delgado and his colleagues in an International Food Policy Research Institute report is underway in the developing countries.

Livestock Revolution:

Per Capita consumption of livestock products is rising fastest where urbanization and rapid income growth result in people adding variety to their diets. For the 1997 to 2020, International Food Policy Research Institute projected that for developing countries aggregate consumption growth rates of meats and milk separately will be 2.9 and 2.7 percent per year each, compared to 0.7 and 0.6 percent per year respectively (Table 2), in the developed world.

Table 2: Projected Food Consumption Trends of Meat and Milk, 1997-2020.

	Projected annual growth 1997-2020 % per year		*Total consumption in 2020 Million tons*		*Per Capita consumption in 2020 Kg*	
Region	Meat	Milk	Meat	Milk	Meat	Milk
China	3.0	3.5	104	23	71	16
India	3.5	3.2	9	132	7	104
Other East Asia	3.2	1.7	4	4	54	29
Other South Asia	3.3	3.0	6	42	12	78
Southeast Asia	3.3	2.9	19	12	29	18
Latin America	2.4	1.8	45	82	69	127
Of which Brazil	2.3	1.7	19	30	92	142
WANA	2.6	2.2	13	42	26	83
SS Africa	3.2	3.3	11	35	12	37
Developing world	2.9	2.7	213	372	35	61
Developed world	0.7	0.4	114	276	84	203
World	2.0	1.5	327	648	44	87

Source: Delgado et al, 2001.

Aggregate meat consumption in developing countries is projected to grow by 102 million tons between 1997 and 2020, whereas the corresponding figure for developed countries is 16 million tons. Similarly, additional milk consumption in the developed countries of 25 million tons of Liquid milk Equivalent (LME) will be dwarfed by the additional consumption in developing countries of 178 million tons (Delgado et al, 2001). As the growth rates in Table 2 suggest, high growth in consumption is spread throughout the developing world and in no way limited to China, India, and Brazil, although the sheer size and vigor of those countries will mean that they will continue to increase their dominance of the world markets for livestock products.

Experience for individual commodities will vary widely among different parts of developing world, with China leading the way on meat with a near doubling of the total quantity consumed; the increments are primarily poultry and pork. India and other South Asian countries will drive a large increase in total milk consumption (Delgado, et al, 2001).

In the developing countries, 70 percent of the additions to meat consumption are from pork and poultry; in the developed countries, the comparable figure is 81 percent. Poultry consumption in developing countries is projected to grow at 3.7 percent per annum through 2020 followed by beef at 2.9 percent and pork at 2.4 percent. In the developed world, poultry consumption is projected to grow at 1.3 percent per annum through 2020, with other meats growing at 0.5 percent or less (Table 3).

Projected Livestock Production Trends to 2020:

Projected production trends for meat to 2020 closely follow those projected for consumption. This means the livestock revolution is propelled by demand.

Table 3: Projected Trends in Meat and Milk Production in 1993-2020.

	Projected annual growth of total production 1997-2020 (Million tons)		*Total consumption in 2020 (Million tons)*		*Per Capita production in 2020 (kg)*	
Region	Meat	Milk	Meat	Milk	Meat	Milk
China	2.9	3.2	86	19	60	13
Other East Asia	2.4	3.9	7	3	55	29
India	2.8	1.6	8	172	6	135
Other South Asia	2.6	3.1	4	46	9	92
Southeast Asia	3.1	2.9	16	3	25	5
Latin America	2.2	2.0	39	80	59	121`
WANA	2.5	2.6	11	46	18	72
Sub-Saharan Africa	3.4	4.0	11	31	10	30
Developing world	2.7	3.2	183	401	29	63
Developed world	0.7	0.4	121	371	87	267
World	1.8	1.6	303	772	39	100

Source: Delgado et al 1999 updated from Rosegrant et al 1997.

Meat and milk production in Developing world projected to grow at rate of 2.7 and 3.2 percent per annum respectively, as a result of this growth rate the total production will reach to the level of 183 million ton meat and 401 million ton of milk, which in turn means a per capita production of 29 kg and 63 kg of meat and milk.

In developed world meat and milk production expected to grow at a rate of 0.7 and 0.4 percent annually between 1993-2020. This means a production of 121 million tons and

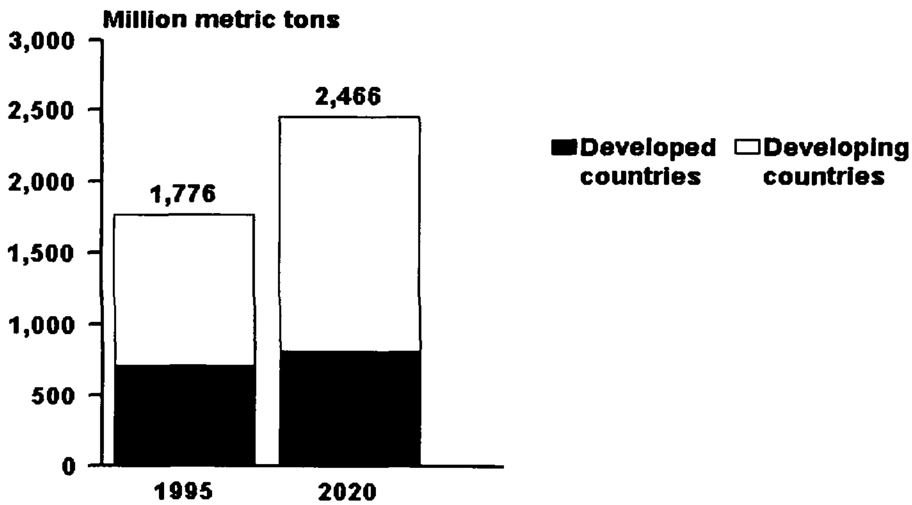
371 million tons of meat and milk respectively, which stands for a per capita production of 87 kg of meat and 267 kg of milk.

World production of milk and meat will grow at rate of 1.8 and 1.6 percent annually between 1993-2020, which means a production of 303 million ton of meat and 772 million ton of milk which in turn stands for a per capita production of 39 kg of meat and 100 kg of milk (Table 3).

Cereal Demand:

Results from IFPRI's revised and updated global food model, the International Model for Policy Analysis of Commodities and Trade (IMPACT), suggest that under the most likely scenario global demand for cereals will increase by 39 percent between 1995 and 2020 to reach 2466 million tons (Figure 3).

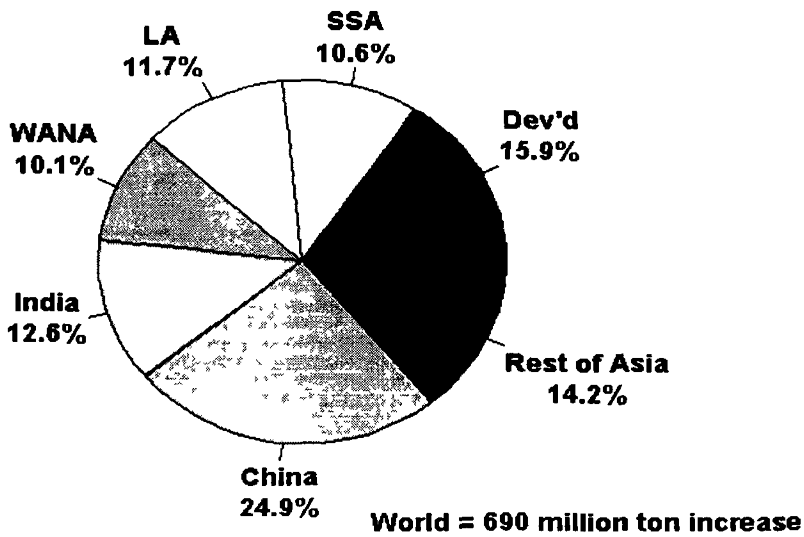
Figure 3: Demand for Cereal 1995 and 2020



Source: Andersen et al. 1999.

Developing countries will account for about 85 percent of the 690 million tons increase in the global demand for cereals between 1995 and 2020 (Andersen and Pandya-Lorch, 2001). Out of this increase in demand share of China , India, West Asia and North Africa, Latin America, Sub Saharan Africa, rest of Asia and developed countries is 24.9%, 12.9%, 10.1%, 11.7%, 10%, 14.2% and 15.9% respectively (Figure 4).

Figure 4: Shares of Increase in Global Demand for Cereals 1995-2020



Source: Andersen et al., 1999.

However a person in the developing country in 2020 will consume less than half the amount of cereals consumed by a person in developed country. Per Capita demand for cereals in developing countries will continue to lag far behind that in developed world. The disparities in demand can be explained partly by lower incomes and greater dependence on roots and tubers for sustenance in developing countries and by much heavier use of cereals for feeding livestock in developed countries.

Within developing world, increase in Per Capita demand for cereals (Food and Feed) in East Asia will far outstrip those in other regions. This is not surprising given that income levels are already relatively high in East Asia and are projected to continue to grow rapidly in the next two decades, triggering massive increase in demand, for instance, while per capita demand in East Asia is projected to increase by 66 kilograms to reach 373 kilograms in 2020, in Sub Saharan Africa it is projected to increase by only 13 kilograms between 1995 and 2020, to reach 156 kilograms in 2020.

As mentioned in the earlier sections of this chapter "a demand driven Livestock Revolution is underway in developing world, with profound implications for global agriculture, health, livestock, and the environment" (Andersen et al, 1999). In response to the strong demand for livestock products the demand for cereals to feed livestock will double in developing countries between 1995 to 2020 to 445 million tons, while demand for cereals for direct human consumption is projected to increase by 40 percent to 1.013 million tons (Andersen et al, 1999). By 2020, 27 % of cereal demand in developing countries will be directed to animal feed, compared with 21 percent in 1995. In developed countries, feed for livestock will account for over 70 percent of the cereals demand, and increase in cereals demand for feed will far outstrip the increase in demand for food between 1995 to 2020.

By 2020, demand for maize in developing countries will overtake demand for rice and wheat. Essentially as income rise, per capita demand for rice is beginning to plateau, but demand for maize for feed proposes is growing substantially; this development has major implications for the world's agricultural production and research systems. Driven by the increased demand for animal feed, demand for maize in developing countries will increase much faster than any other cereal, by a projected 2.35 percent per year between 1995 and 2020 compared with 2.09 percent per year for other grains, 1.58 percent for wheat and 1.23 percent for rice. About 64 percent of maize demand will go toward feeding livestock compared with 8 percent of wheat and 3 percent of rice in 2020. For example, In China where total demand for meat is projected to double between 1995 and 2020, demand for maize is forecast to increase by around 2.7 percent per year whereas demand for rice, the most important staple for human consumption, is projected to increase by only 0.6 percent per year (Andersen et al, 1999).

Demand for Other Staple Food:

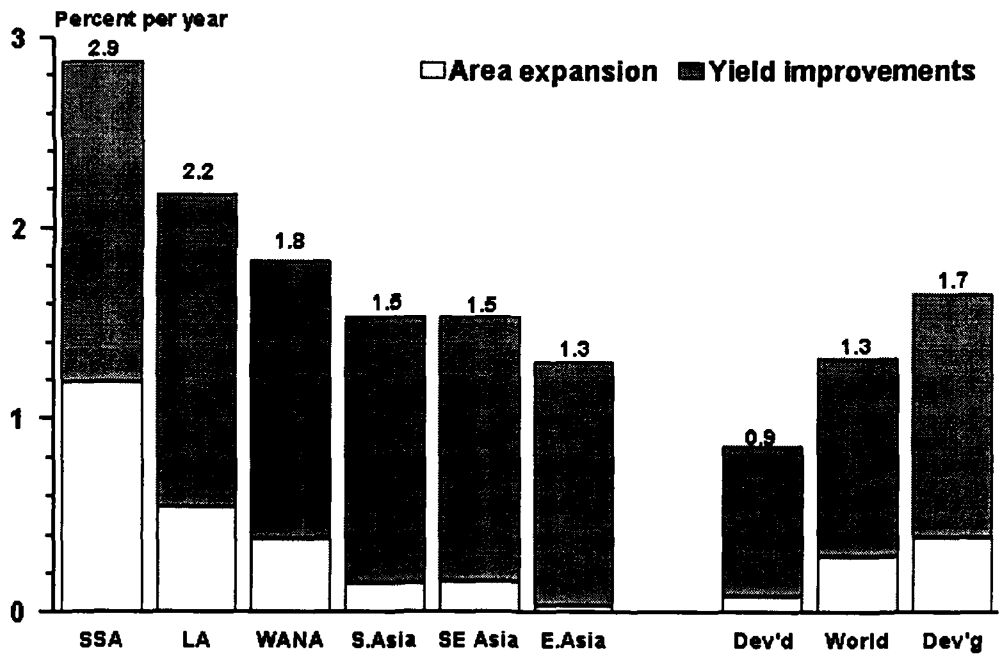
People in developing countries will also increase their demand for other staple food commodities. In many parts of Sub Saharan Africa, roots and tubers, especially Cassava, Sweet Potatoes, and Yams are major source of sustenance. In the late 1990s, they accounted for 20 percent of calories consumed in the region, and the diets of the poor. In much of the Asia and Latin America roots and tubers are an important supplemental source of Carbohydrates, Vitamins, and Amino Acids in food system dominated by other commodities. Between 1997 and 2020 total demand for roots and tubers in the developing worlds will increase by 55 percent to 248 million tons (Scott, et al. 2000)

Sub Saharan Africa is projected to account for 44.93 percent of this increased demand, indicating that roots and tubers will continue to play a large role in people diets there. Asia will also account for a significant amount of the total increase (31.9 %), while Latin America, West Asia, North Africa, and developed world will contribute 8.5%, 3.8%, and 6.5% respectively to total increase to 2020 (Scott, et al. 2000).

Supply Situation:

The world's farmers will have to produce approximately 40% more grains in 2020, most of which will have to come from yield increases. IMPACT projections suggest that farmland cultivated with cereals will increase by only 7.4 percent or 51 million hectares by 2020, with much of the growth concentrated in the relatively low-yielding cereals of sub-Saharan Africa. A modest expansion in cereal area is forecast for Latin America, but virtually no growth is projected for Asia or developed countries. IMPACT projections suggested that global cereal production will grow at an average annual rate of 1.3 percent between 1995 and 2020. While in developing world cereal production will grow at a rate of 1.7% per annum between 1995 to 2020, it will grow at rate of 0.9% in developed worlds during the same period (Figure 5).

Figure 5: Sources of growth in cereal production 1995 to 2020

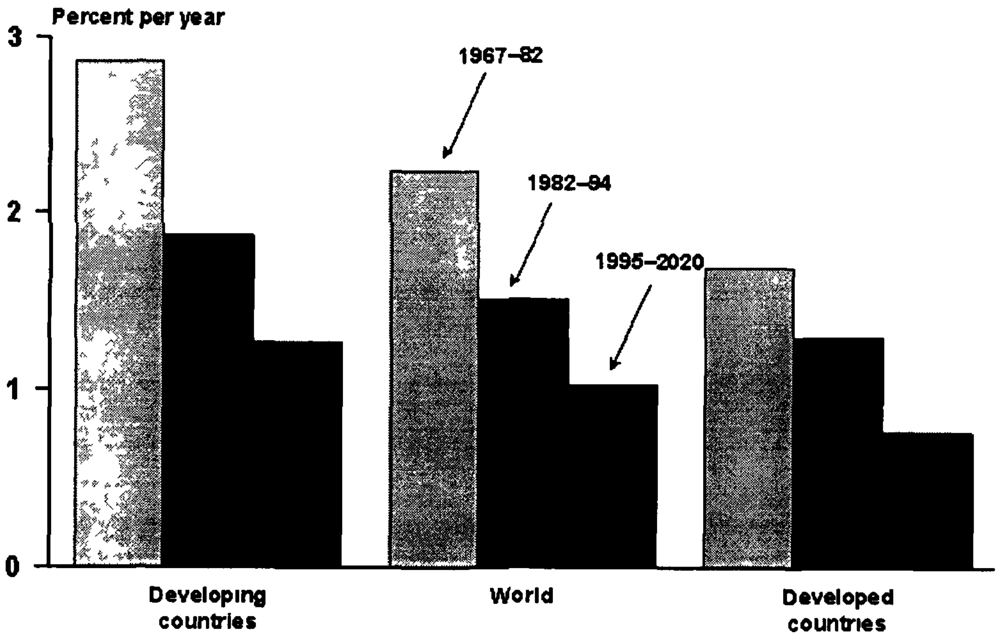


Source: Andersen et al., 1999

Increases in cultivated area are expected to contribute only one-fifth of the global cereal production. Therefore, improvements in crop yield will be required to bring about the necessary production increases (Andersen, et al, 1999).

However, growth in farmers' cereal yields is slowing. In both developed and developing countries, the rate of increase in cereal yields is slowing from the hey day of the Green Revolution in the 1970s (Figure 6).

Figure 6: Annual Growth in Cereal Yields, 1967-82, 1982-94 and 1995-2020

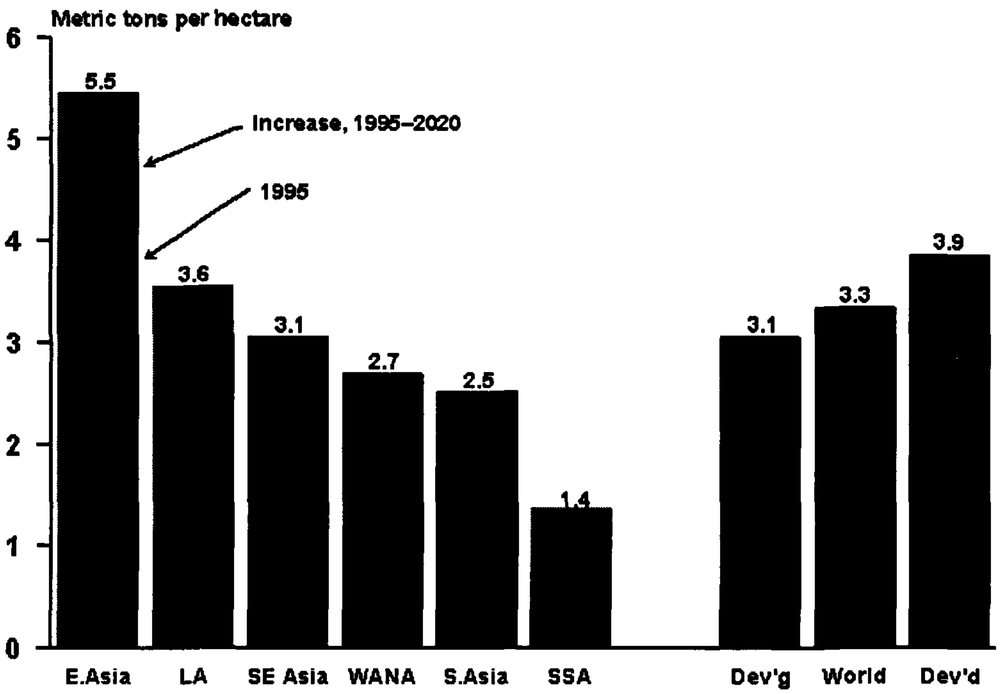


Source: Andersen et al., 1999.

This is partly due to reduced use of inputs like fertilizer, reflecting low and falling cereal prices, and partly to low levels of investment in agricultural research and technology. Poorly functioning markets and lack of appropriate infrastructure and credit are also contributing factors. Without substantial and sustained additional investment in agriculture research and associated factors, it will become more and more difficult to maintain, let alone increase, cereal yields in the longer term.

However the gap in average cereal yields between the developed and developing countries is slowly beginning to narrow, but it is widening considerably within the developing world as sub-Saharan Africa lags further and further behind the other regions, particularly East Asia (Figure 7).

Figure 7: Cereal Yields 1995 to 2020



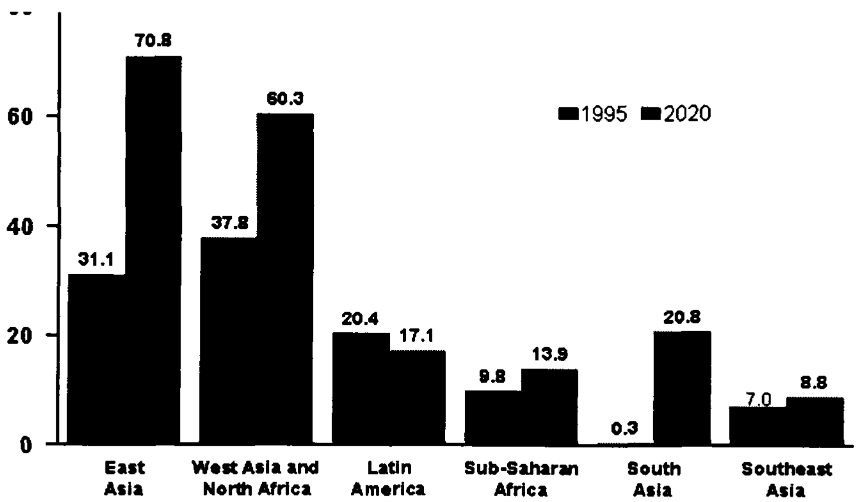
Source: Andersen et al., 1999.

As a result of faster yield increase cereal production will increase much faster in the developing world than in the developed world. Between 1995 and 2020, cereal production in the developing world is projected to increase by 51 percent from 965 million tons to 1460 million tons, whereas in the developed world cereal production is projected to increase by only 24 percent from 812 million tons to 1006 million tons. By 2020, the developing world will be producing 59 percent of the world's cereal up from 54 percent in 1995.

International Market for Food:

As a result of increasing demand and low and stagnating production net cereals imports by developing countries will almost double to fill the gap between food production and demand. Despite large increases, cereal production in developing world will not keep pace with demand. International Food Policy Research Institute (IFPRI) projections suggest that the developing world's net cereal imports will increase by 80 percent between 1995 and 2020 to reach 191.6 million tons. With exception of Latin America all major regions are forecasted to increase their net cereal imports. The massive increase forecast in South Asia's net cereal imports. This increase is because of the fact that production in this region will not keep up with income and population growth, Sub Saharan Africa's net cereal imports are expected to remain low because of lack of foreign exchange and entrenched poverty (Figure 8).

Figure 8: Net Cereal Import of Major Developing Regions 1995 and 2020.



Source: IFPRI, IMPACT simulation 1999.

Wheat will continue more than half of the developing world's net cereal imports, but the share of maize is projected to rise from 28 to 33 percent between 1995 and 2020. Trade in rice is forecast to remain small. About 12 percent of the developing world's cereal demand is projected to be met through net imports from the developed world, up from 10 percent in 1995.

Food Prices:

Food prices will fall between 1995 and 2020. Real world prices of food are projected to decline but at much slower rates than in the past two decades. Cereal prices on average are projected to drop by about US $ 19 per metric tons by 2020 (about 17 Percent). By comparison, between 1982 and 1995, real world wheat prices dropped by 28 percent, rice prices by 42 percent, and maize prices by 43 percent (Andersen et al, 1999). The much slower decrease in food prices, compared with past trends, is due to the continued slowdown in crop yield increases as well as strong growth in demand for meat in developing countries.

Real cereal prices are expected to increase slightly through the year 2010. It is only after 2010 that the continued decline in the rate of population growth, combined with declining income elasticities of demand for cereals, will reduce demand growth enough to cause cereal prices to resume their long term downward trend (Anderson et al. 1999).

STATE OF NATURAL RESOURCES

Irrigation and Water Resources:

During the 1950s to the 1980s, irrigation expanded rapidly and currently accounts for about 72% of global water withdrawals, and about 90% of water use in low-income developing countries. Such a major role for irrigation had been justified by the contribution of irrigation systems to stabilizing, then expanding national and world food supplies during the Green Revolution, especially in Asia (Svendsen and Roregrant, 1994). In the mid-1990s, irrigated agriculture contributed nearly 40% of the world production on 17% of cultivated land. Dramatic increases in yield during and after Green Revolution were achieved, in large part, through the introduction and successful adoption of high-yielding varieties of wheat and rice that depend heavily on timely nutrient and pest control management as well as irrigation applications to secure and control soil moisture (FAO, 1996). Thus irrigated agriculture was a major factor in achieving the yield growth rates described above (Rosegrant and Rignler, 1999).

But the development of new irrigation has slowed considerably since the late 1970s, due to escalating construction costs for dams and related infrastructure, low and declining prices of staple cereals, declining quality of land available for new irrigation, and increasing concerns over the environmental and negative social impacts of large-scale irrigation projects. Moreover, lending for large-scale irrigation projects from international donors declined sharply after the 1970s: loans from four major donors the World Bank the Asian Development Bank, the U.S. Agency for International

Development (USAID), and Japanese Overseas Economic Cooperation Fund (OECF) peaked in the late 1970s, but by the late 1980s were just over 50% of the 1977-79 level (Rosegrant, 1997). These declining expenditures are reflected in the declining growth in crop area under irrigation. Of the current arable land area, about 250 million hectares (17 percent) are irrigated (Postel 1999). The scope for expansion of irrigated land area is limited because the land that is most suitable for irrigation has already been developed, additional land can be brought under irrigation only at high cost, and renewable, fresh-water resources for irrigation are limited especially in the arid and semi arid regions (Gardner-Outlaw and Ergelman 1997). Consequently globally, the growth rate in irrigated area declined from 2.16% per year during 1967-82 to 1.46% in 1982-93. The decline was slower in developing countries, from 2.04% to 1.71% annually during the same period (Rosegrant and Ringler, 1999). Rosegrant et al. (1997) assessed future expansion in irrigated area, consistent with the underlying assumptions in global food projections. Their projection indicates a continued decline in irrigated area growth. In developed countries, irrigated area is expected to increase by only 3 million hectares between 1995 and 2020, at an annual rate of growth of just 0.2%, compared to 0.8% annually during 1982-93. In developing countries, an additional 37 million hectares of irrigated area is projected by 2020, at annual rate of increase of 0.7% compared to 1.7% per year during 1982-93.

India has already developed 76% of the estimated ultimate irrigation potential of 113.5 million hectares (World Bank, 1999). Futuristic growth will be more difficult in physical terms and will be met with virulent opposition from environmental groups (NAAS, 1998). Andersen et al. 1997 projected total area of 68,619 thousand hectares will be irrigated in India by 2020 as against total irrigated area of 50.101 thousand hectares in 1993.

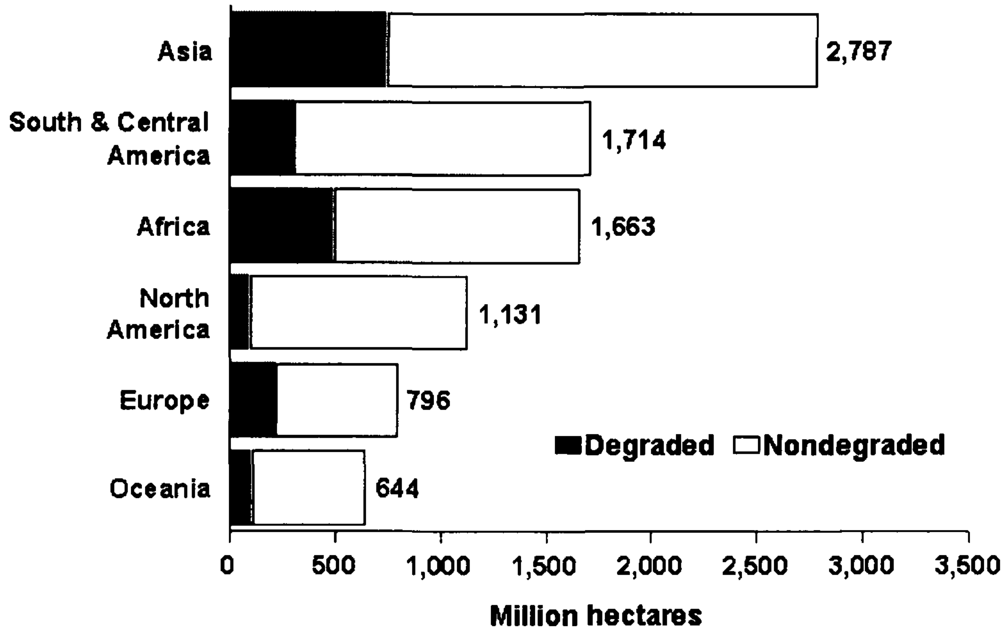
Land Degradation:

Soil degradation is characterized by a decline in soil quality or a reduction in soil's capacity to produce economic goods and services and to perform environmental moderating function (Lal, 1993). Soil degradation adversely affects crop yields both directly and indirectly. Directly, yield reduction are due to declines in effective rooting depth and associated reductions in water and nutrient reserves. Indirectly, soil degradation decreases the response to inputs, such as improved crop varieties, fertilizers, and irrigation (Lal, 2001).

Existing estimates of the current global extent and severity of the problem should be considered indicative at the best. The Global land Assessment of Degradation (GLASOD), based only on the impressions of experts, estimates nearly 2 billion hectares worldwide (22 percent of all cropland, pasture, forest, and wood land) have been degraded since mid century. Some 3.5 percent of the 2 billion total is estimated to have been degraded so severely that the degradation is reversible only through costly engineering measures. Just over 10 percent has been moderately degraded, and this degradation is reversible only through major on-farm investments of the rarely 1.5 billion hectors in cropland world wide, about 38 percent is degraded to some degree. Africa and Latin America appear to have the highest proportion of degraded agricultural land, and

Asia has the highest proportion of degraded forest land (Figure 9).

Figure 9: Global Estimates of Soil Degradation



Source: Scherr, 1999.

Several studies have estimated degraded land area in India. Sehgal and Abrol (1994), using the guidelines of the Global Assessment of Soil Degradation (GLASOD) (Oldeman 1988), estimated total area of 187.7 million hectares of land in India are degraded, out of this 187.7 million hectares are suffering from low level of degradation, while 31.6, 127 and 15.1 million hectares are sufferting from medium, high and very high level of degradation respectively (Sehgal and Abrol 1994).

By the year 2020, land degradation may pose a serious threat to food production and rural livelihoods, particularly in poor and densely populated areas of developing worlds. Land degradation takes a number of forms, including depletion of soil nutrients, salinization, agrochemical pollution, soil erosion, vegetative degradation as a result of over grazing, and the cutting of forests for farmland. All of these types of the land degradation, reducing potential yields. Farmers may need to use more inputs such as fertilizer or manure in order to maintain yield, or they may temporarily or permanently abandon some plots. Degradation may also induce farmers to convert land to lower-value uses. For example, farmers may plant cassava, which demands few nutrients, instead of maize, or may convert crapland to grazing land (Scherr and Yadav, 2001).

Various source suggest that 5 to 10 million hectares are being lost annually to severe degradation. If this trend continues, 1.4 to 2.8 percent of total cropland, pasture, and forestland will have been lost by 2020. (Scherr and Yadav, 2001).

In India, the production of food grains quadrupled between 1947 and 1990, and the contribution of Punjab and Haryana to national production of rice and wheat increased from 4% in 1950-51 to 21% in 1985-86 (ICAR, 1998). Yet the area affected by soil degradation from 113 million hectares in 1947 to 166 million hectares in 1990, and data collected by the Fertilizer Association of India shows that between 1966 and 1992 the incremental response of yields to an additional unit of fertilizer fell by 83% for rice and by 64% for wheat (Hobbs and Morris, 1996)

STATE OF FOOD SECURITY, CURRENT POSITION AND FUTURE CHALLENGES

Food Availability:

With increased production and imports, per capita food availability in the developing world will increase. IFPRI, IMPACT projections indicate that about 2800 calories will be available per person per day in the developing world by 2020 (Table 5).

Increase in per capita food availability are expected in all regions. China is projected to experience the largest increase, and West Asia and North Africa the smallest increase, albeit from already high levels.

At less than 2300 calories per person per day, average food availability in sub Saharan Africa will barely meet the requirements for a healthy and productive life. And since available food will not be equally distributed, many African will have less than the minimum required.

Table 4: Availability of Calorie in Major Economic and Geographic Regions

Regions	*1995*	*1999*	*2020*
West Asia and North Africa	NA	NA	3154
Latin America	2766	2818	3008
Southeast Asia	NA	NA	2882
South Asia	NA	NA	2633
Sub-Saharan Africa	2161	2212	2276
Developing World	2619	2685	2806
Developed World	3186	3239	2902
World	2748	2807	3328

Source: 1995 and 1999 data from FAO, 2002, 2020 data IFPRI, IMPACT simulations, July 1999.

How Many are Hungry:

Food and Agricultural Organization of United Nation in a year 2000 report entitled state of food insecurity 2000 (SOFI, 2000), on the basis of dietary energy supplies, dietary energy supply of the undernourished, minimum energy requirements and deficit of the undernourished classified the world's countries into five broad categories.

- Category one, less than 2.5 percent undernourished in total population.
- Category two, between 2.5 and 4 percent undernourished in total population.
- Category three, between 5 and 19 percent undernourished in total population.
- Category four, between 20 and 34 percent undernourished in total population.
- Category five, 35 percent and above undernourished in total population.

FAO's latest estimate indicates that, in 1997-99, there were 815 million undernourished in the world. This includes 777 million in the developing countries, 27 million in countries in transition, and 11 million in industrialized countries (SOFI, 2001).

For the developing countries, the latest figure represents a decrease of 39 million since 1990-92, this means that the average annual decrease now stands at about 6 million people.

During the period of 1992-99 only 32 out of the 99 developing countries studied by FAO recorded a decrease in their numbers of undernourished. The total reduction achieved by this group amounted to 116 million people. This compares with a total increase of 77 million recorded for the countries in which the number of undernourished rose. Because the first group includes several large countries, such as China, Indonesia, and Thailand in Asia and Nigeria in Africa the total reduction achieved outweighed the total increase in the second. Thus, the number of undernourished has increased considerably in the majority of developing countries.

When the number of undernourished is considered as a proportion of country's total population, instead of in absolute terms, the picture is somewhat different. The proportion actually fell in the majority (58) of developing countries. However, this finding should not be interpreted too optimistically, since in 18 of these countries the fall coincided with a rise in absolute numbers. The decrease in the proportion of undernourished in these countries has not been sufficient to offset the effect of population growth.

Best and Worst Performers:

The best and worst performing countries are found in all developing regions (Table 5).

Table 5: Best and Worst Performers.

Decrease			*Increase*		
Country	No (million)	% of Total	Country	No (million)	% of Total
China	76	66	DR of Congo	17	22
Peru	6	5	India	11	14
Indonesia	5	4	Tanzania	6	8
Nigeria	4	3	DPR korea	5	6
Thailand	4	3	Bangladesh	5	6
Viet Nam	4	3	Afganistan	3	4
Brazil	3	3	Venezuela	3	4
Ghana	3	3	Uganda	2	3
Pakistan	2	2	Kenya	2	3
Sudan	2	2	Iraq	2	3
All others	7	6	All others	21	27
Total	116	100	Total	77	100

Source: FAO 2001.

Among the countries analyzed, the two extremes of performance are represented by China, a country that achieved stunning aggregate economic growth in the 1990s and a socio-economic transformation rivaling that of Southeast Asia in the 1970s and 1980s; and the conflict stricken Democratic Republic of Congo a potentially very rich country which has seen its proportion of undernourished grow from 35 percent in 1990-92 to 64 in 1997-99. It should be noted that, despite China's performance, the country is still home to the world's second largest number of undernourished people after India.

As already indicated the majority of developing countries suffered significant increases in their number of undernourished. This worrying trend, masked by much better performance of a few. Given population growth, reversing the trend requires either faster growth in per capita food availability or more equitable access to food or a combination of both. The relative importance of these two avenues to reduce hunger, however, varies with the specific situation of a country and various prevailing factors at a particular point of time.

As expected the first group (worst performers) had a far higher population growth rate and a much lower growth rate in per capita food availability than the group with a decline in numbers of undernourished. Furthermore, in the first group, per capita food and agriculture production growth rates are both much lower than those of the second group, which highlights the vital role of agricultural development in promoting faster growth in food availability (Table 6).

Table 6: Average Annual Growth Rate of Population, Dietary Energy Supply, Capital Formation and External Assistance to Agriculture

	Average annual growth rate from 1990-92 to 1997-99				*Change from 1990-92 to 1997-99*	
Country grouping	Total population %	Per capita dietary energy supply%	Per Capita food production %	Per capita agricultural production %	Net capital stock in agriculture (US $)	External assistance to agriculture per worker (US $)
1- Countries where the number of undernourished increased significantly	2.1	0.1	0.4	0.4	-65	-14
2- Countries where the number of undernourished decreased significantly	1.4	1.4	3.8	3.4	118	-1

Source: FAO, 2001.

Table 6 also provides information on changes in the domestic and external resources allocated to agriculture, corresponding to these two country grouping.

The contrast regarding change in resources directed to agriculture emerge more sharply when the group of best performers is compared with the worst performers (Table 7).

Table 7: Changes in Resources Directed to Agriculture in The Best and Worst Performing Country Grouping.

Country grouping	*Net capital stock in agriculture per worker (US $)*	*External assistance to agriculture per worker (US $)*
Best performers	88	5.3
Worst Performers	-158	-31.0

Source: FAO, 2001.

Undernourishment around the world:

Knowing the number of Calories missing from the diets of undernourished people helps round out the picture of food deprivation in a country. The depth of hunger, or food deficit, is measured by comparing the average amount of dietary energy that undernourished people get from the foods they eat with the minimum amount of dietary energy they need to maintain body weight and undertake light activity. The diet of most of the 800 million chronically hungry people lacks 100-400 Kilo Calories (FAO, 2000).

Table 8: Number and Percentage of Undernourished in Developing World

Region	*% of Population*			*Millions of People*		
	1996-98	2015	2030	1990-92	2015	2030
Sub Saharan Africa	34	22	15	186	184	165
Near East/North Africa	10	8	6	36	38	35
Latin America and Caribbean	11	7	5	55	45	32
China and India	16	7	3	348	195	98
Other Asia	19	10	5	166	114	70
Developing Countries	18	10	6	791	576	400

Source: Agriculture: Towards 2015/2030, Technical Interim Report, FAO, April 2000.

The figure for 2015 indicate that the overall proportion of the developing countries population that is undernourished will be half what it was in 1990-92, the base period for the world food summit target. But the number of undernourished people will not reduce by the same proportion (50%) and it will still be around what it was in 1990-92.

If the goal were applied regionally, South and East Asia would be on track to approach it by 2015. Sub Saharan Africa and the Near East would remain far from the target, and Latin America would be in between.

Overall, these outcomes would reflect the continuation of long-term decline in the prevalence of undernourishment in Asia, which began in 1969-71 in East Asia and a decade later in South Asia.

For China and India combined, the prevalence of undernourishment is projected to decline from 16 percent in 1996-98 to 7 percent in 2015. Together they represent more than one third of the world's population so any change in their levels of undernourishment has a large effect on world averages.

With business as usual, hunger and malnutrition will remain prevalent and persistent. A food secure world will be realized only if broad based economic development is accelerated, particularly in low income developing countries; investment in research, technology and infrastructure are enhanced; women have a greater voice in decision making at all levels; low-income people in both rural and urban areas, especially women, gain greater access to remunerative employment, productive assets, credit, markets, education, clean water, and health care.

Chapter 3

Identifying the Food Insecure; The Application of Individual Calorie Intake Approach.

Indian Experience on Food and Nutritional Security:

Food security is often considered at different levels such as global, regional, national, sub-national, household, and individual levels. While the early concerns had been mainly confined to global and regional food security, during the last two decades the focus has shifted to food security concerns at the national, local, households and individual levels, and this shift has modified and enlarged the concept itself. Food security is about availability of food and access to sufficient income to purchase food and effective utilization of food within the household[1].

Though food production in India has been increasing, uneven distribution of income leaves several sections of population undernourished. Around one-third of population are considered as food insecure, consuming less than 90 percent of the minimum energy requirement. This people are chronically hungry as hunger can be defined as a condition in which people do not get enough food to provide the nutrients for fully productive, active and healthy lives.

Food insecurity in India is basically rural phenomenon as the bulk of today's hungry consist of landless and near landless people who sell their labor to earn a living, but their earning capacity is usually unacceptably low. In other words these people are those who are suffering from lack of access to opportunities to grow. And when they fail to gain access to opportunities in rural areas they migrate to urban centers in search of job.

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[1] For a brief account on evolution of concept see chapter 1.

For the propose of measuring food security in India, let us begin by distinguishing four different questions about a country's achievements in relation to ensuring adequate nutrition for all. Each points to a particular focus of attention:

1. Is the country self-sufficient in food?
2. Does the country have an adequate food availability?
3. Do the people in the country have sufficient food entitlement?
4. Do the people have adequate nutritional capability?

There are casual links between the respective points of attention in these questions. For example, achieving food self-sufficiency can be one way for country to ensure adequate food availability. Having an adequate supply of food will generally help, to a varying extent, the guaranteeing of sufficient food entitlements for all. And securing an adequate entitlement to food must contribute to a person's nutritional capability (Dreze and Sen, 1998).

Question of Self-Sufficiency:

It has been argued, with some justice, that the dependence of a country on importing food from abroad for the survival of its own population can be a major source of vulnerability for that country. This does not, however, imply that a country less dependent on importing food from abroad would necessarily be better off in terms of food consumption or nutritional levels than another which is more dependent in this respect. The issue of self-sufficiency is, obviously, quit a distinct one from that of the adequacy of food supply, and nothing is gained by confounding the two concepts. Countries like Japan, Switzerland, or the United Kingdom depend a great deal on importing food from abroad, but their populations do not, to say the least suffer from food inadequacy, compared with, say, the people of self-sufficient Burma, Uganda, or India. One factor that has been responsible for the confounding of the two different ideas of food self-sufficiency and food adequacy is the observed fact that countries which have become increasingly dependent on food imports from abroad have also developed problems of food inadequacy and hunger within the economy (Dreze and Sen, 1998).

Prolonged and directed efforts to raise food production have played a primary role in India's social and economic development planning for much of its more than 50 years of independence. And despite a rapidly growing population, improvements to country's food system have been made: production has increased to record levels, imports of food grains have declined, famine has disappeared, and per capita increases in food supply have been realized. On the basis of these successes, the federal government concluded in its Ninth Five-Year Plan that food self-sufficiency had been achieved and has gone so far as to discuss developing a wheat-base agricultural export industry. However, this official conclusion warrants caution. For this is not the first time country has claimed success. To give two examples: in September 1955, shortly after implementation of the country's First Five-Year Plan, the minister of agriculture. A.P.Jain, announced to the lower house of national legislature, the *Lok Sabha*, that the country's food position had taken such a favorable turn that it was "now possible to begin exporting variety of food grains, including the main dietary staples, rice, and wheat, and that not even poor weather in future would adversely effect the country's overall long-run food situation" (Jain 1955). And in 1984 the years of good crop return gave rise to demands in prominent national newspapers for the government to do something with the country's "embarrassing" food surpluses (Ezekial 1984). Indeed, as one analyst concluded, such claims are a theme in the country's planning process: "A succession of two or three good harvest has invariably prompted policy makers to take credit for the good performance, to assert that stability in agricultural output, has been achieved, and to prepare plans for entering the export market" (Hanumantha Rao, 1994).

Household food security is a function not only of availability of food but also the purchasing power available with each household. It is said that India has achieved self-sufficiency in the matter of food grains but what exactly one means when one says this. In India's case it refers to the fact that India is no longer required to import food grains and can even export some and even when it has to resort to imports once in a while, it is a very small quantity and that too only once in a while. For example, in the last decade India imported negligible amount of cereals only in three years (1990, 1993, and 1994) and in rest of the decade even emerged as a minor exporter. India has therefore, achieved self-sufficiency in food grains production in that particular manner of understanding of self-sufficiency.

India certainly can legitimately take pride in being able to manage the existing demand for food grains with indigenous production. But what about the suppressed demand, the demand that should have been there but it is not there due to poverty? Effective demand and consequent consumption of required quantity of food grains is not what it should be;

other wise millions would not have been below poverty line not being able to consume at least minimum level of calories even if we keep other nutrients out of consideration (Table 1).

Table 1: Estimates of Poverty

Year	*All India Number (million)*	*Poverty Ratio (percent)*	*Rural Number (million)*	*Poverty Ratio (percent)*	*Urban Number (million)*	*Poverty Ratio (percent)*
1973-74	321	54.9	261	56.4	60	49.0
1977-78	329	51.3	264	53.1	65	45.2
1983	323	44.5	252	45.7	71	40.8
1987-88	307	38.9	232	39.1	75	38.2
1993-94	320	36.0	244	37.3	76	32.4
1999-2000	260	26.1	193	27.1	67	23.6

Source: Economic Survey 2001-2002.

Many of households, have, therefore, inadequate access to food and are food insecure. "The root cause of such non-access or food insecurity is poverty and one has to understand this in order to appreciate the contradiction between food self-sufficiency on the one hand and prevailing malnutrition on the other" (Nawani 1994). This lack of access or lack of purchasing power has been forcefully brought out by Amaratya Sen when he describe it as deprivation due to non entitlement or "the inability of certain people to command food through the legal means available in the society, including the use of production possibilities, trade opportunities, entitlement vis-à-vis the state and other methods of acquiring food" (Sen 1981). He goes on to say that a "person starves either because he does not have the ability to command enough food or because he does not use this ability to avoid starvation" (Sen, 1981).

National Food Security:

How far India has succeeded in attaining the objective of increasing physical and economic access to food since independence needs to be analyzed, before prescriptions can be given for a future course of action. India has had a long history of famines with the last major one where 1.5 million people lost their lives occurring in 1943 in Bengal. To the credit of India, no such large-scale starvation has recurred since that time. In several years during the post-independence period, when the domestic production of food grain fell sharply, such as 1955, 1966-67, 1973-75, 1979 and 1987, conditions were ripe for a famine, but each time the disaster was successfully averted (Ramachandran, 1994). In this context, Tyagi (1990) quotes from Reutlinger (1978), 'the government of India was able to manage, by and large, this difficult situation by administrative means, mobilization of extra grain supply from abroad, and thereby avoid widespread catastrophic famine'.

One of the best measures of gauging food security situation at national level is to compare growth rate of production of staple foods with the annual growth rate of population. Such practice has been attempted in table 2.

Table 2: Population Growth and Growth Rate of Food Grain Production (1951-2001).

Year	*Population (In million)*	*Average Annual Growth (Percent)*	*Growth Rate of Food grain Production*
1951	361.09	1.25	
1961	439.23	1.96	4.8
1971	548.16	2.2	2.1
1981	683.33	2.22	2
1991	846.39	2.14	3.3
2001	1027.02	1.93	1.66

Source: Population data, from Indian economic survey 2001-2002, growth rate of food grain production author's calculation.

In India annual rates of population growth rose from 1.96% in 1950s to 2.2% during the 1960s and 2.22% during 1970s and have fallen only slowly since then (2.14% & 1.93% during 1980s and 1990s). Comparing the rate of growth for population and food grains production shows growth rate of food grains production higher than population growth rate during 1950s and 1980s and below it during the 1960s, the 1970s, and the 1990s. Over the entire period food grains production grew faster at 2.75% per annum than did population at 2.08 %.

Transposing food grain quantities and population numbers into single per Capita production values precisely reflects the impact population has had on production (Table 3).

Table 3: Per Capita Production of Food Grains in India, 1961-2001.

Year	*Population (Millions)*	*Per capita production kg/yr*	*Per Capita production of rice and wheat kg/yr*	*Per Capita production of pulses & coarse cereals kg/yr*
1961	442	185	103	82
1971	551	197	120	77
1981	689	188	131	57
1991	852	207	152	56
1996	942	192	148	44
1997	960	208	157	51
1998	978	197	152	45
1999	997	204	158	46
2000	1015	207	163	44
2001	1033	190	150	40
2002	1052	199	156	43

Source: Economic Survey 2001-02.

Thus, When resources (especially land) and technology constraints limit the aggregate food production, its negative impact on food security at the household and individual levels can be minimized to some extent by the efforts on curtailing population growth rates within tolerable limits.

Physical Availability:

I. Production and Availability of Food Grains:

Physical access to food can best be measured in terms of per Capita availability of food grains (Table 4).

Table 4: Net Availability of Food Grains (per day) in India from *1951* to *2000.*
(Grams Per Capita Per Day)

Year	*Rice*	*Wheat*	*Other Cereals*	*Cereals*	*Gram*	*Pulses*	*Food Grains*
1951	158.9	65.7	109.6	334.2	22.5	60.7	394.6
1952	158.5	57.6	109.3	325.4	19.8	59.1	384.5
1953	165.9	62.5	121.5	349.9	24.2	62.7	412.6
1954	194.1	58	136	388.1	27.3	69.7	457.8
1955	179.7	58.3	134.9	372.9	31	71.1	444
1956	187.7	61.5	11.2	360.4	29	70.3	430.7
1957	192.7	71.6	111	375.3	32.8	71.8	447.1
1958	164.5	66.5	119	350.3	25.3	58.5	408.8
1959	191	78.5	123.9	393.4	35.5	74.9	468.3
1960	187.8	78.3	118	384.1	27.7	65.5	449.6
1961	201.1	79.1	119.5	399.7	30.2	69	468.7
1962	203.2	84.2	111.5	398.9	27.3	62	460.9
1963	186.9	79.2	117.9	384	24.7	59.8	443.8
1964	201.4	90.1	109.5	401	20.3	51	452
1965	210.2	93.6	114.7	418.5	25.5	61.6	480.1
1966	161.9	95.4	102.6	359.9	18.3	48.2	408.1

1967	154	90.5	117.3	361.8	15.3	39.6	401.4
1968	183.7	95.8	124.6	404.1	24.6	56.1	460.2
1969	190.5	100.5	106.8	397.8	17.4	47.3	445.1
1970	190.2	102.3	110.6	403.1	21.9	51.9	455
1971	192.6	103.6	121.4	417.6	20	51.2	468.8
1972	197.8	126	95.3	419.1	19	47	466.1
1973	172	118.1	90.4	380.5	16.7	41.1	421.6
1974	190.4	108.8	11.2	410.4	14.8	40.8	451.2
1975	158.9	112.1	94.8	365.8	14.2	39.7	405.5
1976	187.2	79.5	107.1	373.8	20.2	50.5	424.3
1977	168.8	114.5	103	386.3	18.4	43.3	429.6
1978	196.2	126.3	100	422.5	17.8	45.5	468
1979	200.3	132.3	99.2	431.8	18.6	44.7	476.5
1980	166.1	126.8	86.6	379.5	10.7	30.9	410.4
1981	197.8	129.6	89.9	417.3	13.4	37.5	454.8
1982	193.2	127.9	94.8	415.9	14	39.2	455.1
1983	169.8	144.4	83.3	397.5	15.6	39.5	437
1984	197.8	140.8	98.9	437.6	13.7	41.9	479.5
1985	188.8	138.5	87.9	415.3	12.9	38.1	453.4
1986	212	151	70.7	433.7	16.2	43.8	477.5
1987	206	157.8	71	434.8	12.3	36.4	471.2
1988	188.2	154.2	68.8	411.2	9.6	36.4	447.6
1989	215	156.2	80.3	451.5	13.4	41.9	493.4

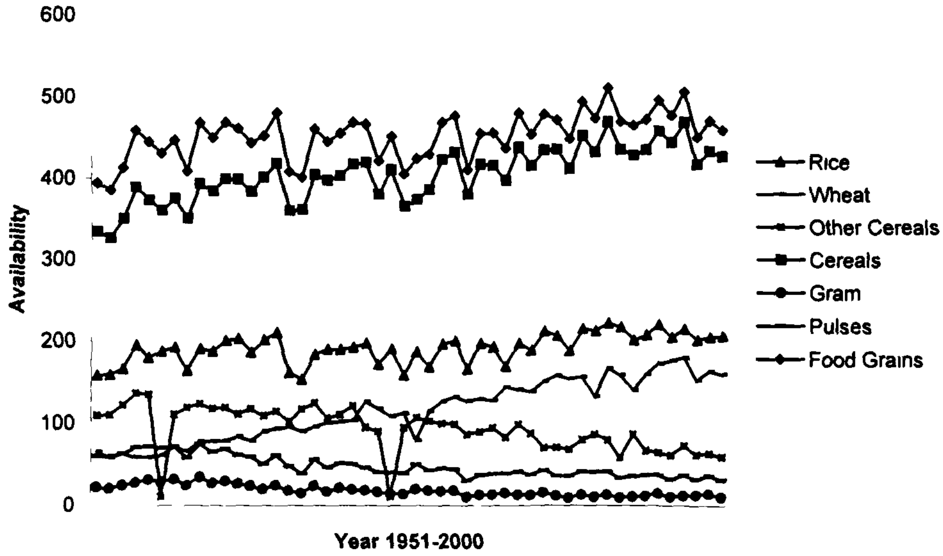
1990	212.1	132.6	86.8	431.5	10.7	41.1	472.6
1991	221.7	166.8	80	468.5	13.4	41.6	510.1
1992	217	158.6	58.9	434.5	10.1	34.3	468.8
1993	201.1	140.2	86.6	427.9	10.7	36.2	464.1
1994	207.4	159.5	67.1	434	11.8	37.2	471.2
1995	220	172.6	64.9	457.5	14.8	37.8	495.3
1996	204.9	176.5	62.2	443.6	11.3	32.6	476.2
1997	215	180	73.3	468.2	12.4	37.3	505.5
1998	201.8	152.6	62.9	417.3	13.5	33	450.3
1999	205.4	163.9	64	433.5	14.7	36.9	470.4
2000	206.4	160.1	60.1	426.8	10.8	31.9	458.6

Source: Departments of Agriculture & Co-operation: Statistics at a Glance 2000.

The trends in per capita supply of food grains, which can be considered as an indicator of the improvements in food security at the individual level indicate that there had been a consistent upward trend in the per Capita production of cereals and a consistent downward trend in the per capita production of pulses and coarse cereals (Figure 1).

Although, there have been fluctuations in the year-to-year per capita availability of food grains, the underlying trend has been one of increase (Figure 1). From an availability of 394.6 grams of food grains per capita per day in 1951, which amounted to 86 % of the basic requirement of 400 grams per day, physical availability has risen to 458.6 per day grams in 2000, which is 115 % of the requirement.

Figure 1: Net Availability of Food Grains (per capita per day grams) in India 1951-2000.



Source: Departments of Agriculture & Co-operation: Statistics at a Glance.

While figures related to rice and wheat are moderately above the immediate post independence level, the unpleasant fact is that per Capita availability of pulses, grams, and cereals other than rice and wheat showed a decreasing trend. In case of pulses the availability decreased from the level of 60.7 grams per day to 31.9 grams per day a decrease of almost 50%, grams and other cereals are also showing similar tendencies as availability of them decreased by 52% and 45% respectively. Thus, advance in Per Capita availability of rice and wheat as a result of Green Revolution were at the cost of decrease in production and availability of other food grains.

II. Supply of Food Items other than Food Grains:

The most extensive record of global food disposition is provided by the Food and Agricultural Organization of United Nations (FAO), which has been compiling in its food balance sheets statistics for 300 primary food, agriculture and fishery commodities for about 200 countries and territories on an annual basis since 1961. Food balances are calculated at the national level on the basis of production, imports, exports, changes in stocks, quantities fed to livestock, used for seed, put to industrial and other non-food uses, and lost during storage transportation, and processing (Hopper, 1999).

Condensed food balances for India at selected intervals between 1937 and 1998 are shown in table 5 on a kg/year basis, per capita availability of basic food stuff reflects the limited gains that have occurred in per capita production. Overall per capita supplies of most of foods in the mid 1990s were marginally above those estimated for 1937 and 1960, and moderately above the low immediate post independence levels of 1950.

Notably, among foodstuffs other than food grains, per capita supplies of vegetables and starchy roots doubled, and supplies of fruits increased by a third in the period of 1960-98. At the same time per capita supplies of sugar, vegetable oils and meat increased by small amount. Milk has acted somewhat uniquely in the Indian food system; it was the only principal foodstuffs to show a prolonged decrease in supplies. Between 1937 and the late 1970s per capita supplies fell by almost 50 percent, before recovering to roughly pre independence levels by 1998.In all instances prorating changes in per capita supplies on a daily basis shows that the increases are very modest. For example, the per capita increase of food grains of 10 kg/year is equal to approximately 27 gr/person/day, the increase of 3kg of vegetable oil is equal to 8 gr/person/day, and the increase of 21.6kg of milk is equal to 59gr/person/day, the increases, respectively, are equal to less than one slice of bread or about half a chapatti, about a teaspoon of vegetable oil, and one-third cup of milk.

Table 5: Per Capita Supplies of Basic Foodstuffs in India, 1950- 98(kg/person/year)

Commodity	*1937*	*1950*	*1960*	*1970*	*1980*	*1990*	*1995*	*1996*	*1997*	*1998*
Rice	75.1	54.7	72.1	68.1	67.5	78.0	76.5	78.9	79.2	80.4
Wheat	21.2	21.0	27.8	35.7	45.7	53.7	58.3	62.4	58.0	61.2
Coarse cereal	41.7	35.1	44.0	42.9	36.3	31.3	28.8	30.6	28.1	26.8
Pulses	23	19.2	23.0	16.6	12.5	13.7	13.3	11.3	13.1	11.4
Food grain total	161.0	130.0	166.9	163.3	162.0	176.7	179.6	183.2	178.4	179.8
Vegetables	na	na	na	42.5	47.7	52.2	74.0	53.2	53.4	54.1
Fruits	25.1	20.1	26.5	26.2	26.5	28.7	34.8	34.1	34.6	34.1
Starchy roots	8.0	7.9	10.4	17.0	19.7	19.8	21.3	20.9	24.7	19.7
Sugar	15.0	13.9	19.2	19.2	19.9	22.7	23.1	22.0	24.7	25.9
Vegetable oil	3.0	4.1	4.1	4.1	5.3	6.5	7.1	7.7	8.2	7.1
Milk	64.0	46.6	38.6	33.6	39.2	54.7	60.2	60.5	61.6	63.1
Meat	6.4	3.3	5.9	6.9	7.5	9.4	9.9	9.3	9.3	9.2

Source: FAO, Food Balance sheet, 2000.

III. Supply of Energy and Protein:

A comparison of total supplies of energy and protein over time shows that the increases that occurred have been limited (see Table 6). Energy supply and protein supply both increased at the rate of 1 percent per year during 1980-98. Over the entire period however, energy supplies increased by only 22 percent, and protein supplies by only 7 percent. Given the time span under consideration this is a poor performance. It is also a poor performance by international standards and by comparison to other nearby Asian countries that had low levels of supply in the 1950s.

To count just two examples, Japan was devastated after World War II but managed with rapid economic expansion to quickly raise its food supplies. By 1960 it had increased per capita energy supplies more than 25 percent to 2460 kcal. By 1995 supplies had risen to almost 2900 kcal, for 1950-95 increase exceeding 50 percent, neighboring China experienced decreasing energy supplies during the 1950s, falling below Indian levels by the early 1960s. Yet China has managed to raise its levels by 70 percent even with a population larger than India's. The developing world as a whole has increased per capita energy supplies twice as fast as India since 1960 (Hopper, 1999).

Table 6: Per Capita Per Day Availability of Calorie, Protein (Grams) in India, 1937-98.

	Plant foods		*Animal foods*		*Total supply*	
Year	Energy (kcal)	Protein (Grams)	Energy (Kcal)	Protein (grams)	Energy (Kcal)	Protein (Grams)
1937	1828	47	193	9	2021	56
1950	1515	37.3	116	5.6	1631	42.9
1955	1785	45.1	105	5.3	1890	50.4
1960	1955	47.3	113	6.2	2068	53.4
1965	1896	44.5	106	5.9	2002	50.1
1970	1932	45	105	6	2036	51
1975	1849	42.2	111	6.3	1960	48.5
1980	1959	44.1	119	6.7	2077	50.8
1985	2060	46	150	8.3	2210	54.2
1990	2178	48	159	8.8	2336	56.8
1995	2221	48.7	173	9.5	2394	58.2
1996	2291	49.4	182	10	2472	59.5
1997	2298	49.6	185	10.2	2483	59.9
1998	2284	48.9	182	10	2466	59

Source: FAO, 1946; FAO 1949-60 and FAO Stats 2000, ***http://www.fao.org***

Note: all quantities based on three-year average except 1996,1997, and 1998.

HOW MANY HAVE ENOUGH?

I. Nutritional Intake:

A healthy and nutritionally well-fed population is indispensable for economic growth and development. Health and nutritional status affect the capacity to learn, which in turn determines productivity and economic growth. Studies show that a healthy adult with a nutritionally adequate diet has a higher level of economic productivity in both own-farm production and labor market than one who eats and keeps less well. Moreover the interaction of inadequate dietary intake and disease leads to malnutrition, disability, and death (Flores, 2001). Adequate nutrition increases option for conservation or at least reduces pressure on people to use resources unsustainably in the effort to meet basic needs (Johns and Eyzaguirree, 2002).

The nutritional status of population is determined by its intake of energy, protein, and fat. Nutritionists have evaluated requirements and have recommended balanced diet. It is food that takes care of the requirements; a balance diet is one, which meet requirements of energy and other nutrients. However, the actual food taken to satisfy these requirements varies according to available food as well as factors such as consumers' preferences, income and relative prices of different items. Thus, the nutritional requirements may be satisfied through a variety of combinations of different food products.

However, the calorie based definition of food security has some weaknesses. In brief, the major problem with the calorie norm is to determine what could be considered as adequate number of calories. In India, as in several other developing countries, the calorie norm is taken as basis for definition of poverty line, i.e., those having calorie intake above certain level being defined as non poor and the rest as poor, a serious, but inconclusive, debate continues with different scholars maintaining different standards of adequacy. In any case, it is clear that the norms of adequate calorie will vary depending on external environment and the nature of activity of an individual. Thus, calorie requirement for a person in humid climate may be different from that of one in dry and harsh climate. Similarly, calorie requirement of a person pursuing a sedentary lifestyle will be different from the one engaged in manual labor. Another serious lacunae of the calorie norm is that calorie adequacy cannot be equated to a healthy and active life. This is evident from the fact that while more and more people are able to access adequate calories, this is not reflected in a sizeable reduction in malnutrition. Dietary energy supply measurement based on average availability of calories at the household level, besides failing to reveal intra-household distribution of food doesn't reflect true nutritional status. Even if we assume that adequate calories are available to every member of the household there is no certainty that available calories will meet the requirements of protein energy, and micro-nutrients such as iron, iodine and vitamin A.

Despite all these shortcomings in most cases household or individual calorie intake are the only available way and the most accurate way for measurement of food security in a given society (See Hoddinot, 1999, and 2001).

II. Nutritional Requirements in Indian:

Determining the biological needs of the Indian population requires detailed calculation and assumption to arrive at representative values. The task is complicated by the fact that individuals differ widely in their nutritional requirement by virtue of body size, gender, age, and activity level. For example, energy requirements can vary from less than 700 Kcal/day for a child during the first year of life, to more than 3500 kcal for a male-aged 30 years performing manual labor. There is also definition of adequacy itself. What level of health is acceptable, for example, and should it include additional nutritional intake for leisure time activities (Hopper, 1999).

One of the most widely accepted definitions of nutritional adequacy is that of the Joint FAO/WHO/UNU expert committee on nutrition (World Health Organization 1985), which defines adequacy as the level of intake that will balance energy expenditure when an individual has a body size and composition and level of physical activity consistent with long-term good health and performance of economically necessary and socially desirable tasks.

The Indian council of Medical research (ICMR) has made recommendations for the dietary requirements of Indian population by age, sex and the level of physical activities. Some important parameters and requirements are shown in table 7.

Table 7: Recommended Dietary Allowance for Indians

Category	*Energy (Calories/day)*	*Protein (Gams/day)*	*Fat (Gams/day)*
Men:			
Sedentary work	2425	60	20
Moderate work	2875		
Heavy work	3800		
Women:			
Sedentary work	1875	50	20
Moderate work	2225		
Heavy work	2925		
Pregnant	+300	+15	30
Lactating	+500	+22	45
Children:			
1-3 years	1240	22	25
4-6 years	1690	30	25
7-9 years	1950	41	25
Boys:			
10-12 years	2190	54	22
13-15 years	2450	70	22
16-18 years	2640	78	22
Girls:			
10-12 years	1970	57	22
13-15 years	2060	65	22
16-18 years	2060	63	22

Source: ICMR (Indian Council of Medical Research), 1994

The variation in requirements by age, sex and type of physical activity is quite large. For healthy growth and optimum productivity, these requirements need to be met.

According to one estimate of FAO (FAO, 1996), the average energy requirement of Asian population is 2150 calories per day. The Planning Commission, Government of India, has worked out 2400 and 2100 calories minimum requirement for Indian in rural and urban areas. The minimum calorie intake has been used in India to define poverty line for the rural and urban people. The rationale is that if a person cannot afford to buy the minimum level of energy (calorie Intakes), his or her income level is too low and can be considered below the poverty line. The National Sample Survey Organization (NSSO) conducted a nutrition intake survey in 1993-94. It crosses the daily per capita intake of nutrition against monthly expenditure classes, separately for rural and urban areas (the level of expenditure has been taken as the indicator of income). The NSSO has been using a daily norm of 2700 calories per consumer unit and actual consumption levels were compared against this norm to determine the adequacy of diet.

III. Nutritional Intake in Rural Areas:

The estimates of per capita daily intake and per consumer unit daily calorie intake for rural areas obtained from the 50^{th} round of NSSO (Last time when calorie intake survey was conducted in India) indicate an average level of 2,153 Kcal and 2,683 Kcal respectively. Though the average daily intake per consumer unit is very close to the specified norm (2700 Kcal), there were wide variations among the different expenditure groups. In the rural areas, the average per diem per consumer unit remained below

2,700Kcal for all consumers with a monthly per capita expenditure level below Rs 265. Thus 51.9 percent of rural consumers had experienced calorie deficiency.

Table 8: Calorie Intake in Rural Areas.

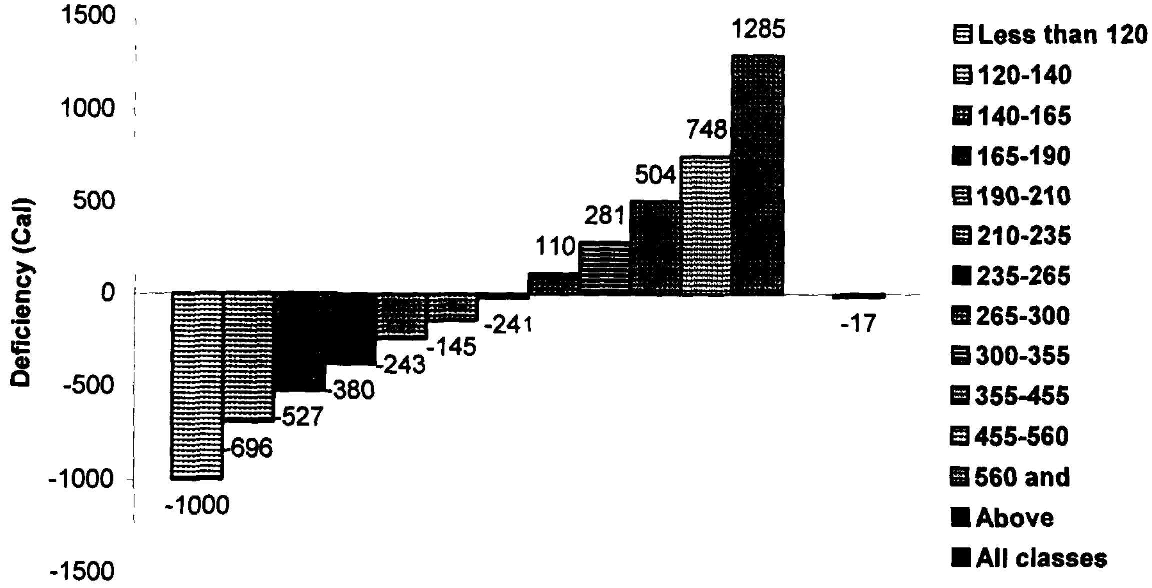
Monthly per capita expenditure classes	*Percentage of sample consumer*	*Per consumer unit per diem intake*	*Percentage of Cereals*
Less than 120	3.6	1700	83.4
120-140	4.1	2004	81.4
140-165	7.3	2173	79.9
165-190	9.3	2320	78
190-210	7.7	2457	76.6
210-235	9.4	2555	74.3
235-265	10.5	2676	72.6
265-300	10	2810	70.7
300-355	12.1	2981	68.2
355-455	12.3	3204	64.2
455-560	6.3	3448	60.9
560 and above	7.4	3985	55.2
All Classes	100	2683	71

Source: Sarvekshana, Oct-Dec, 1997.

The level of deficit as percentage of minimum calorie requirement shows an inverse relationship with income (expenditure). It differs from 37.04 percent for lowest monthly per capita expenditure class to less than 1 percent in the last expenditure class (235-265) that experienced calorie deficiency. Similarly the dependency on cereal as source of energy showed inverse relationship with income (expenditure) that means as income (expenditure) grows dependency on cereals as source of energy decreases (it is 83.4 percent for lowest expenditure class which reduces to 55.2 percent for highest expenditure class).

The calorie deficiency or depth of hunger in absolute terms also shows an inverse relation with income (Figure 1). It is 1000 calorie in lowest per Capita expenditure (income) class as income (expenditure) increases the depth of hunger decreases. It reached to 24 calorie in the last income class, which reported calorie deficiency.

Figure 2: Calorie Deficiency (Depth of Hunger) for Different Monthly Per Capita Expenditure Classes in Rural Areas.



Source: Sarvekshana, 1997.

IV. Nutritional Intake in Urban Areas:

The calorie intake in urban areas also indicates similar tendencies as in rural areas. In case of urban areas the minimum norm of 2700 kcal is reached only for expenditure class of 490 and above (table 9).

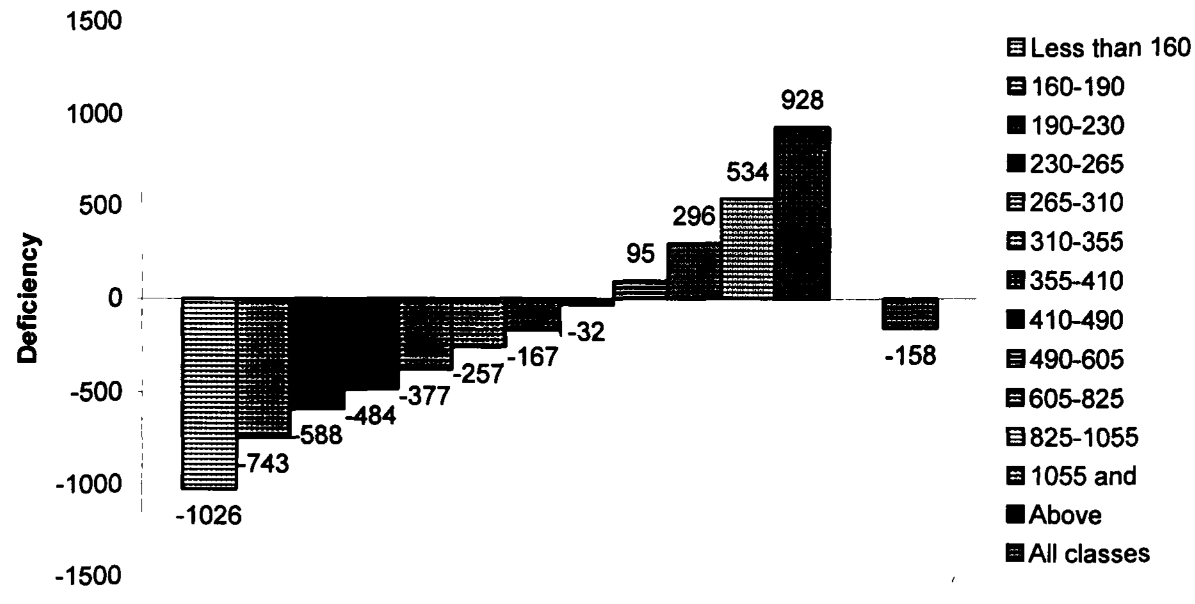
Table 9: Calorie Intake in Urban Areas.

Monthly per capita expenditure classes	*Percentage of sample consumer*	*Per consumer unit per diem intake*	*Percentage of Cereals*
Less than 160	4.4	1674	76.8
160-190	4.4	1957	74.1
190-230	8.8	2112	71.4
230-265	8.8	2216	68.7
265-310	10.9	2323	65.8
310-355	9.5	2443	63.2
355-410	10	2533	60.1
410-490	10.9	2668	57.1
490-605	10.3	2795	53.1
605-825	10.3	2996	49.0
825-1055	4.7	3234	42.9
1055 and above	7	3628	38.5
All classes	100	2542	58.5

Source: Sarvekshana October-December 1997.

In other words 67.7 percent of urban population in India were suffering from calorie deficiency at the time of survey. Same as rural areas as income increases the calorie deficiency or depth of hunger reduces; it is 1026 calories in lowest expenditure class, which reaches to 32 calorie for highest expenditure class that shows the calorie deficiency (Figure 2). Same as rural areas the dependency on cereals as source of energy decreases in urban areas as income rises. The dependency on cereals as source of energy is 76.8 percent in lowest expenditure class, as expenditure (income) increases the dependency on cereals decreases and reaches to 38.5 percent for expenditure class of 1055 and above.

Figure 3: Calorie Deficiency (Depth OF Hunger) for Different Per Capita Expenditure Classes In Urban Areas.



Source: Sarvekshana, 1997.

Assuming 90% of 2700 calories as adequate norm we can reach the conclusion that in rural areas those who are in expenditure class of less than Rs. 190 per month are food insecure, similarly in urban areas those who are in expenditure class of less than Rs. 310 per month could be branded as food insecure. Therefore, in rural and urban areas 24.3 and 37.3 percent of population could be classified as food insecure.

Using these proportions and applying them to recent population figures gives an indication of current numbers of food insecure. The result which should be fairly accurate since the average level of calorie availability have not changed significantly over the past decade, show that as many as 286 million people are not meeting their minimum daily energy requirements. Out of this, 180 (63%) are living in rural areas and 106 million (37%) are located in urban areas. Thus, it is justified to say that problem of food security in India is a rural phenomena as majority of food insecure are located in rural areas, moreover the majority of urban food insecure, are migrants from rural area. This finding is in tune with result of a recent opinion poll, which has been done by International Food Policy Research Institute in its International conference on sustainable food security for all by 2020.

V. Nutritional Situation in States:

The most salient feature of the National Sample Survey Organization data is the deeply disturbing finding that, at all India level average calorie intake declined steadily in rural and urban areas between 1972-73 and 1993-94.

In rural India, average calorie intake fell from 2266 calorie in 1972-73 to 2221 in 1983 and to 2153 in 1993-94. In urban India, the average intake was lower than in rural India. At the same time the reduction in intake was smaller in urban India than in rural India;

intake went down from 2107 calorie in 1972-73 to 2089 in 1983 and 2071 in 1993-94.

There were, however, exceptions to the overall trend of decline in calorie intake. There were only two states in which the calorie intake per person increased between 1972-73 and 1993-94 in rural and urban areas: Kerala and West Bengal. West Bengal's performance was noteworthy in two respects. First, calorie intake per person improved in rural and urban areas between 1983 and 1993-94 and over the longer period 1972-93. Secondly, calorie intake per person in West Bengal, which was below the national average in 1972-73, moved to a position above the national average in 1993-94

Between 1972-73 and 1983, the only states in which the average calorie intake per person in rural areas rose were Karnataka, Kerala, Mharashtra, Orissa and West Bengal. In the next decades, 1983 to 1993-94, the average calorie intake in rural areas rose in only three states (Kerala, west Bengal, and Orissa). If the entire period (that is , 1972-73 to 1993-94) is considered, calorie intake per person rose in the rural areas of four states (Kerala, west Bengal, Orissa, and Maharashtra). The largest absolute increase in calorie consumption per day was in Kerala (406 cal) which was followed by West Bengal (290 cal), Orissa (204 cal) and Maharashtra (44 cal). In West Bengal and Orissa, the average intake per person moved from below the all India average in 1972-73 and 1983 to a level above the all India average in 1993-94. The average intake in Kerala and Mharashtra were, however, below the national average in all years (Table 10).

Land reform was implemented relatively early in Kerala. The state also has India's most effective system for the Public Distribution of food as well as high level of school education and widespread public health system.

In West Bengal, land reform and democratic system of Panchayats (one that actually represents the rural poor) triggered the highest level of agricultural growth in India in the 1980s and early 1990s. as a consequence of these policies, there was a reduction in income poverty in rural West Bengal which has been translated in the sphere of actual food consumption as well.

Table 10: Per capita Intake of Calorie in Rural Areas by States and NSS Round.

State	*27th round 1972-73 (Cal)*	*38th round 1983 (Cal)*	*50th round 1993-94 (Cal)*
Andhara Pradesh	2103	2204	2052
Assam	2074	2056	1983
Bihar	2225	2189	2115
Gujarat	2142	2113	1994
Haryana	3215	2554	2491
Himachal Pradesh	2954	2636	2324
Jammu & Kashmir	3151	2569	2507
Karnataka	2202	2260	2073
Kerala	1559	1884	1965
Madhya Pradesh	2423	2323	2164
Mahrashtra	1895	2144	1939
Orissa	1995	2103	2199
Punjab	3493	2677	2418
Rajastan	2730	2433	2470
Tamil Nadu	1955	1861	1884
Uttar Pradesh	2575	2399	2307
West Bengal	1921	2027	2211

Source: Sarvekshana, 1997.

In urban India too, average calorie intake fell between 1972-73 and 1983, and fell again between 1983 and 1993-94. Between 1972-73 and 1983, the only states for which NSS data showed a rise in average urban calorie intake were karnataka, Kerala, Maharashtra, and Tamil Nadu. NSS data record an increase in calorie intake between 1983 and 1993-94 in the urban areas of a larger number of states, including Assam, Bihar, Gujarat, Jammu and Kashmir, Orissa, Uttar Pradesh and West Bengal. With respect to the period 1972-73 to 1993-94 as a whole however calorie intake per person in urban areas rose in only five states, namely Kerala, Karnataka, West Bengal, Tamil Nadu, and Maharashtra. Again, the largest absolute increase in calorie consumption per person per day was in Kerala (243 cal); Kerala was followed by Karnataka (101 cal) and West Bengal (51 cal) (Table 11).

Table 11: Per Capita Intake of Calorie in Urban Areas by States and NSS Round.

State	*27th round 1972-73 (Cal)*	*38th round 1983 (Cal)*	*50th round 1993-94 (Cal)*
Andhara Pradesh	2143	2009	1992
Assam	2135	2043	2108
Bihar	2167	2131	2188
Gujarat	2172	2000	2027
Haryana	2404	2242	2140
Himachal Pradesh	2961	2429	2416
Jammu & Kashmir	2467	2234	2392
Karnataka	1925	2124	2026
Kerala	1723	2049	1966
Madhya Pradesh	229	2137	2082
Mahrashtra	1971	2028	1989
Orissa	2276	2219	2261
Punjab	2783	2100	2089
Rajastan	2357	2255	2184
Tamil Nadu	1841	2140	1922
Uttar Pradesh	2161	2043	2114
West Bengal	2080	2048	2131

Source: Sarvekshana, 1997.

Another noteworthy feature of the NSS data is that in the rural areas of four states (Punjab, Hrayana, Himachal Pradesh and Jammu and Kashmir) average calorie intake fell by more than 600 cal per person per day (in Punjab, the fall was actully of the magnitude of 1075 cal per person per day). The decline in nutritional intake thus steepest in states where initial levels of calorie consumption were the highest in India.

The data on urban areas also shows a sharp reduction in nutritional intake in the states where initial consumption levels were highest (including Punjab, Haryana and Himachal Pradesh).

Requirement of Cereals for Meeting Calories Deficit:

Based on the estimates of calorie intake of different expenditure groups, it is possible to estimate the quantity of cereal required to bridge the calorie gap. As indicated earlier, in the rural areas calories gap existed in all expenditure groups with monthly per capita expenditure up to Rs. 265. Among the consumers with per capita monthly expenditure of less than Rs. 120, the calories gap was 1000 kcal and by the time they reached the required level of calories, 72 percent of the calories would be obtained from cereals. This implies an additional consumption of 225 gms of cereal per day to meet the calories gap. When the requirements for the other calorie deficit expenditure classes were estimated it was observed that the weighted average of additional cereal consumption requirement to meet the calories deficit of all groups was 95 gms per day which implies an additional consumption of 39 gms per day for the total rural population. Similar estimates for the urban areas indicated an additional consumption of 68 gms per day for the calories deficit groups and 46 gms per day for the total urban population. Thus an additional consumption of 41 gms of cereals per day is required to bridge the calories gap of the total population.

Applying this amount (41 gms), to the population level reported in Indian Economic Survey 2001-02 one can reach to the interesting results. To fill the calories gap in the year 2001 there was requirement of 15.4 million tons of cereals. This amount is equal to sum of change in government stock (12.5 million tons) and exports of cereals (2.9 million tons), which is 15.4 million tons. Thus, increase in government stocks and exports is a result of lack of effective demand for food and no any other reason, and if purchasing power improves in such a way that every one can get enough calories, then India will face difficulty to accumulate cereals stocks from domestic production.

Purchasing Power and Food Security:

Economic access to food can be measured by assessing the proportion of per capita income required to buy a unit of food. If over a period of time, this proportion reduces, it can be assumed that access to food in economic terms has increased (Ramachandran, 1994).

Food is the single largest expense for most of people in India, where it accounts for 59.42 % and 47.96 % of total expenditure in rural and urban areas respectively. However, the intra-group differences based on income variations are persisting. Table 12, shows the percentage of expenditure on food items to total expenditure for different Monthly Per Capita Expenditure Classes (MPCE) for rural and urban areas in 50th and 55th round of

National Sample Survey.

Table 12: Percentage of Expenditure on Food to Total Expenditure, by Different Monthly Per Capita Expenditure Classes.

MPCE	*Rural*		*Urban*	
	50th Round	55th Round	50th Round	55th Round
1	73.59	67.37	71.63	64.81
2	74.07	66.78	71.05	63.46
3	73.74	66.00	70.27	61.80
4	73.33	64.96	68.8	59.98
5	72.48	64.72	67.01	57.53
6	71.4	63.82	65.19	56.38
7	70.4	62.83	62.99	54.03
8	63.47	61.69	60.39	51.80
9	66.65	60.33	56.6	49.33
10	62.88	57.62	53.1	45.40
11	58.19	54.69	43.81	41.18
12	43.62	46.28	34.9	46.46

Source: Author's calculation from National Sample Survey Data 50th and 55th Round

Between 50th round of National Sample Survey 1993-94 to 55th round 1999-2000, the percentage of expenditure on food items to total expenditure shows a decreasing trend for all expenditure classes except the highest expenditure class. This means people are spending smaller proportion of their income on food items. The increase in proportion of expenditure on food for highest income group may be as a result of the fact that they increased their consumption of processed food and beverages between 1993-94 to 1999-2000.

In aggregate, between 50th round of National Sample Survey and 55th round in urban areas percentage of expenditure on food items to total expenditure shows decreasing trend, it dropped from 54.59% in 1993-94 to 47.96 which shows 6.69% decrease (Table 13).

Table 13: Expenditure on Food and Non-Food Items in Urban & Rural Areas in Different NSS Rounds.

	50th Round	*51st Round*	*52nd Round*	*53rd Round*	*54th Round*	*55th Round*
Urban						
Expenditure on Food Items	250	271	300	320	340	410.86
Expenditure on Non-Food Items	208	237	299	325	344	444.10
Total expenditure	458	508	599	645	684	854.96
Rural						
Expenditure on Food Items	178	189	199	232	232	288.80
Expenditure on Non-Food Items	104	121	137	163	150	197.28
Total expenditure	281	309	344	395	382	486.07
Urban (Percentage of Expenditure on Food & Non-Food to Total Expenditure)						
Food	54.59	53.35	50.08	49.61	49.6	47.96
Non-Food	45.41	46.65	49.92	50.39	50.4	52.04
Rural (Percentage of Expenditure on Food & Non-Food to Total Expenditure)						
Food	63.35	61.17	57.85	58.73	60.8	59.42
Non-Food	36.65	38.83	42.15	41.27	39.2	40.58

Source: Author's calculation from different rounds of National sample Survey Organization (NSSO) surveys.

In rural areas, while the percentage of expenditure on food to total expenditure is higher than urban areas, between 50^{th} round of National sample survey to 55^{th} round it shows also a similar trend as in the case of urban areas, but there is only 3.93% decrease between 50^{th} round to 55^{th} round.

In annual terms situation is more unsatisfactory, between 1993-94 to 1999 in urban areas there was annually only 1.1% reduction in percentage of outgo on food to total expenditure, while in rural areas this percentage dropped just at the rate of 0.655% annually, which both of them stand for nothing in relation to initially high proportion of expenditure on food to total expenditure.

Changing Quality of Diet in India:

When households or individuals become better off, they consume a wider variety of foods; a diverse diet is a valid welfare indicator in its own right. The nutrition literature is placing increasing emphasis on the importance of consuming a wide variety of foods so as to enhance dietary quality in addition to longer-standing concerns regarding quantities of consumption.

There is evidence to suggest that Indians have begun to consume less food grains per capita by substituting non-cereal foods. This downward shift in demand for food grains can basically be attributed to changing consumer taste and preferences as a result of increasing availability of a wide variety of food items other than food grains (Hanumantha Rao, and Gulati, 1994). A recent document of International Food Policy Research Institute (IFPRI) attributed the increase in demand for fruits, vegetables, and animal products to both income growth and shifts in taste and preferences (Oshaug and Haddad, 2002).

In India, the 55th Round (1999-2000), of the National sample Survey (NSS) on household consumption confirms the trend of declining share of consumption expenditure on food, and within food, on food grains in particular (Table 14).

Table 14: Monthly Per Capita Food and Food Grains Expenditure to Total Expenditure.

Year/NSS Round	*Share of Food Expenditure in Total Consumption Expenditure*		*Share of Food Grains Expenditure in Total Consumption Expenditure*	
	Rural	Urban	Rural	Urban
197-73 (27th Round)	72.9	64.5	46.0	27.1
1977-78 (27th Round)	64.3	60.0	37.3	24.5
1983 (38th Round)	65.6	59.1	36.3	22.9
1987-88 (43rd Round)	64.0	56.4	30.6	18.7
1993-94 (50th Round)	63.2	54.7	28.3	17.3
1999-2000 (55th Round)	59.4	48.1	26.2	15.3

Source: Indian economic Survey, 2001-2002.

It is important to note that share of other foods namely fruits/vegetables, milk, fish, eggs, etc. has relatively gone up (Table 15).

Table 15: Share of Expenditure on Food Grains, Fruits/Vegetables & Milk, Meat, Egg, Fish in Total Food Expenditure

NSS Rounds	*Expenditure on Food Grains*		*Expenditure on Fruits & vegetables*		*Expenditure on Milk, Meat, Egg & Fish*	
	Rural	Urban	Rural	Urban	Rural	Urban
27th round	63.1	42.02	10.15	9.92	13.44	19.53
32nd round	58.01	40.83	9.95	10.67	16.17	21.67
38th round	55.34	38.75	11.43	12.01	16.01	21.66
43rd round	47.81	33.16	12.66	13.83	18.59	23.23
50th round	44.78	31.63	14.4	14.99	20.25	24.13
55th round	44.11	31.81	14.48	15.59	20.37	24.53

Source: Indian Economic Survey, 2001-2002.

Chapter 4

Measuring Risk of Entitlement Failure: How Many and Who Will Be at Risk

Risk Factor and Food Security:

Ensuring that all the world's people have enough food for a healthy and productive life is among the most fundamental challenges we face. Now, even though global food output is adequate to feed the entire world population, more than 800 million people are going hungry because they cannot afford to buy the food they or their families need. In India too the equivalent situation prevails, at present around 286 million people or about 30 percent of population could be branded as food insecure. Ironically, these people are going without enough intake of food at the time when buffer stock of more than 60 million tons of food grain is available with government agencies.

Food security is a concept that has evolved considerably over time and there is much literature on potential household food security indicator. There are approximately 200 definitions and 450 indicators of food security (Hoddinott, 1999). Perhaps the most accepted one is World Bank definition according to the which food security can be defined as access by all people at all times to enough food for an active, healthy life. Its essential elements are the availability of food and ability to acquire it. Some definitions incorporated the concepts like sustainability and social and cultural acceptability in the definition of food security. While some others have highlighted the risk factor in their definition of food security. Von Braun et al, 1992 studied the factors, which bring about risk to food security situation of a household or individual. C.P. Timmer, defined food security as an environment in which the lowest income quintile has a near zero probability of being vulnerable to famine (Timmer, 2000).

A household's or individual food security is measured by determining whether or not by fully exercising the means at its disposal, it has access to enough food during all seasons of the year. In India keeping in mind large scale of food stocks and possibilities of import, the risk associated with food security can not be attributed with merely variation in the crop production in bad monsoon years. But there are sets of wider factors, which are operating at national and international level that have direct and/or indirect effects on income of households and prices of food.

The level of food security existing in the country is a complex of interactions operating at different levels from the macro to micro or household level. The components of the system would include international trade and macro policies, the agriculture sector, the market economy, consumption patterns, and the micro economy or household incomes, urban rural differentiation, gender issues, etc. (Khan and Bidabadi, 2001). This set of factors are able to produce a price or income shock. Even if the magnitude of price or income shock is relatively high, the households/individuals with diversified income and expenditure pattern can tolerate the shock without using severe coping strategies such as reduction of food consumption.

For India to deal with risks of people being exposed to food insecurity, there is need to identify its worst food security problems in terms of risks and population exposed to them and give the highest priority to tackling them. A prerequisite for determining risk is defining a scale against which to measure an outcome (Dilley and Boudreau 2001). In this analysis the outcomes are physical availability which itself is affected by variability in production, and economic access to food, which is under the effect of price rise or income failure. In this Chapter with the help of production and availability data from Government sources, Food and Agricultural Organization of United Nation (FAO), and National Sample Survey Organization data on households and individual expenditure an attempt has been made to assess the vulnerability of India's population to variability in production and availability and rise in food prices or reduction in income of households or individuals.

Concept of Vulnerability:

In 1981, Sen challenged the then widely held conviction that lack of food availability (or supply) was the primary explanation for famines; instead, he hypothesized lack of access (or effective demand) as the key to understanding who went hungry and why. Because access issues are entrenched in social, political and economic relations, Sen's work represented a clear shift in emphasis from natural to societal causes of famine (Blaikie et al, 1994). Authors who sought to operationalize Sen's ideas for assessment and famine prevention purposes began to invoke the word "vulnerability" to refer to the complex web of socio-economic determinants outlined by Sen (see Swift, 1989; Borton and Shoham, 1991; Maxwell and Frankenberger, 1992; Ribot 1995; Middleton and O'Keefe, 1998).

To be vulnerable is to exist with a livelihood that some kind of crisis may occur that will damage one's health, life, or property and resources on which health and life depend. Everyone is, to some degree, vulnerable (Anderson, 1995). Downing, 1991 defined vulnerability as a term, which refers to consequences, rather than a cause. Using vulnerability in reference to cause insinuates a negative consequence without completing the reference. [E.G.] to assert that nations are vulnerable to drought implies a casual linkage between drought and an unspecified negative impact.

With everyone vulnerable to some degree, the task of analyst is to identify just how close to the edge any given group has slipped, although the edge may be arbitrarily determined. The scale for measuring vulnerability can be relative, with no minimum, no maximum, and no threshold. The analysis may be limited to judging from year to year whether a specific group may have become more or less vulnerable than it was before due to changing exogenous circumstances. Establishing the circumstances under which certain group of people might be more vulnerable than other, and why, is a subjective judgment of the analyst rather than a theoretical necessity.

When vulnerability is freed of contingency on specification of particular, concrete threats, at one end of the spectrum, it can achieve the status of an independent phenomenon in its own right.

Specifically, vulnerability is complex, dynamic, compounding and cumulative, sometimes irreversible, and frequently impossible to contain (Anderson, 1995). Alternatively it may become ethereal and elusive: assessing vulnerability is like trying to measure something that is not there. It is an absence of security, basic needs, social protection, political power and coping options that define the problem, making the search for a visible reference point a difficult task (Webb and Harinarayan, 1999). In its most expansive form, it can be as vast as the eternal human condition.

Vulnerability is all about the context of human responses to potential suffering. It is about a set of conditions that are worse than they should be and possibly they are continuing to worsen (Webb and Harinarayan, 1999). Vulnerability here refers to exposure to contingencies and stress, and difficulty in coping with them. Vulnerability thus has two sides: an external side of risk, shocks and stress to which an individual or household is subject, and an internal side which defenselessness, meaning a lack of means to cope without damaging loss (Chambers, 1989).

Risk Assessment:

Depending on factors such as agro-ecological characteristics, access to land, diversity of income sources and state of development of the economy, food insecure households can be members of different socio-economic and demographic groups in different areas. Nevertheless, some common characteristics of food-insecure people emerge of which poverty and income constraints are central one. "The poor face the most severe constraint in their food production and in their access to food from market, which renders them vulnerable to food security crises" (Von Braun et al, 1992). A number of common socio-demographic characteristics emerged from a comparative study that looked at income source patterns of malnourished rural poor in 13 survey areas in Africa, Asia, and Latin America (Von Braun and Pandya-Lorch 1991):

- Food insecure households tend to be larger and to have a higher number of dependents and a younger age composition.
- Ownership of land or access to even small pieces of land for farming has a

substantial effect on the food security of rural households, even when income level is controlled for; the prevalence of food insecurity tends to be higher among landless or quasi-landless households, who are much more dependent on riskier sources of income than farm income and on the diversification of the rural economy;

- Women's income has an important influence on the food security status of the household; and female-controlled income is more likely to be spent on food and nutrition than male-controlled income.

- The relationship between income diversification and malnutrition is difficult to generalize; the relationship is context and location-specific and is a result of household coping strategies. A typology of food insecure households needs always to be aware of this context and location specificity (Haddad, Sullivan, and Kennedy, 1991).

Typically, food insecure people spend a large share of their income on staple food consumption or allocate a large share of their production resources to subsistence food production in normal years, or both; yet they barely meet their needed level of dietary intake.

Different types of risks affect different groups of food – insecure house holds and individuals Box 1 summarizes the different type of risks, their sources, and affected population.

Box 1: Sources of Risks of Food Insecurity and Affected Populations

Risks	*Households and People at Risk of Food Insecurity*
Crop production risks (Pests, drought, and others)	Small holders with little income diversification and limited access to improved technology such as improved seeds, fertilizer, irrigation, and pest control. Landless farm laborers.
Agricultural trade risks (Disruption of exports or imports)	Small holders who are highly specialized in an export crop. Small-scale pastoralists. Poor households that are highly dependent on imported food. Urban poor.
Food price risks (Large, sudden price rises)	Poor, net food-purchasing households.
Employment risks	Wage-earning households and informal sector employees (that is, in peri-urban areas and, when there is a sudden crop production failure, in rural areas).
Health risks	Entire communities, but especially households that cannot afford preventive or curative care and vulnerable members of these households.
Political and policy failure risks	Households in war zones and areas of civil unrest. Households in low-potential areas that are not connected to growth centers via infrastructure.
Demographic risks (Individual risks affecting large groups)	Women, especially when they have no access to education. Female-headed households. Children at weaning age. Aged.

Source: Von Braun et al, 1992.

Variability in Production and Availability of Food:

The risk that is attached to physical availability of food is outcome of variation in the level of availability of food; the variation in physical availability of food is effected by the variation in production, which in turn itself is under the effect of variation in area under cultivation and yield. The coefficient of variation of area, yield and production of food grains in India during the 1970s, 1980s and 1990s indicate that variability in food grain production has increased during the 1980s over the 1970s but between the 1980s and 1990s there has been a decline in the variability. The increased variability in production during the 1980s can be mainly attributed to the increased variability in yield level in spite of a reduction in the variability in area under food grains. During the 1990s both area and yield levels indicated a reduction in variability. The declining variability in food grain production during the 1990s has been uniformly experienced by rice, wheat, coarse grains and pulses, and in all these cases yield variability has declined. However, for wheat and coarse grains there was an increased level of variability in area which was offset by the reduction in the yield variability. The increased variability in production of food grains during the 1980s was reflected in increased variability for rice and coarse grains, but there was reduced variability for wheat and pulses. Further, during the 1980s there was a reduction in the variability of area under rice, wheat and pulses, but yield variability increased for all crops except pulses (Table 1).

Table 1: Direction of Changes in Variability Between 1970s to 1980s and 1980s to 1990s

	1970s to 1980s			*1980s to 1990s*		
	Area	Yield	Production	Area	Yield	Production
Crops	-	+	+	-	-	-
Rice	-	+	-	+	-	-
Wheat	+	+	+	+	-	-
Coarse grains	Neg.	+	Neg.	-	-	-
Total cereals	-	-	-	-	-	-
Pulses	-	+	+	-	-	-
Total food grain	-	+	+	-	-	-

+Increase; - Decrease; Neg: Negligible

The variability in production levels was somewhat offset by stock adjustments and trade so that variability in availability was substantially reduced. As indicated in Table 2, during all the three decades, the variability in per capita availability of cereals remained at a lower level than the variability in per capita production.

Table 2: Coefficient of Variation in Area, Yield, Production and Availability.

(1)	*1970s*	*1980s*	*1990s*
	Area		
Rice	3.21	3.15	1.24
Wheat	8.31	3.26	4.52
Coarse cereals	3.86	4.73	5.48
Total cereals	2.20	2.24	1.35
Pulses	4.47	3.73	3.68
Total Food Grains	2.25	2.35	1.65
	Yield		
Rice	8.58	13.66	4.25
Wheat	8.02	9.90	5.29
Coarse cereals	9.38	19.16	10.34
Total cereals	8.52	10.32	5.59
Pulses	11.58	6.91	6.21
Total Food Grains	7.82	9.88	5.69
	Production		
Rice	11.44	15.58	4.93
Wheat	15.48	11.77	8.63
Coarse cereals	9.64	20.66	10.40
Total cereals	10.59	10.46	5.70
Pulses	12.44	8.56	6.93
Total Food Grains	9.98	10.15	5.58
	Availability		
Cereals	5.71	5.06	3.93
Pulses	9.85	9.45	8.57
Total Food Grains	5.49	5.25	3.87

Calculating coefficient of variation of per capita per day availability of calorie, protein, and fat during 1970s, 1980s, and 1990s, shows that in case of availability of calorie 1990s had lowest level of variation (3.09) followed by 1970 (3.36) and 1980s (5.13) in case of protein the lowest level of variation in availability obtained during 1970s (2.99) followed by 1990s (3.02) and 1980s (5.15). While variation in per capita availability of fat is much more higher than variation in per capita availability of calorie and protein during all three decades, it shows same trend as variation in per capita availability of protein, its lowest level is obtained during 1970s followed by 1990s and highest level of variation is calculated during 1980s (Table 3).

Table 3: Coefficient of Variation of Per Capita Per Day Availability of Calorie, Protein and Fat in India.

	1970s	*1980s*	*1990s*
Calorie	3.36	5.13	3.09
Protein	2.99	5.15	3.02
Fat	4.20	6.27	5.51

Source: Author's calculation from FAO food balance, sheets, 2002, http://www.fao.org

Risk of Entitlement Failure:

If a group of people fails to establish their entitlement over an adequate amount of food, they have to go hungry; the entitlement of a person stands for the set of alternative commodity bundles that can be acquired through the use of the various legal channels of acquirement open to that person. In a private ownership market economy, the entitlement set of a person is determined by his original ownership bundle (what is called endowment) and various alternative bundles that the person can acquire, starting with each initial endowment, through the use of trade and production (What is called his exchange entitlement). A person has to starve if his entitlement set does not include any commodity bundle with an adequate amount of food. A person can be reduced to starvation if some economic change makes it no longer possible for her to acquire any commodity bundle with enough food to survive. This entitlement failure can happen either because of a fall in her endowment (e.g. alienation of land, or loss of labor power due to ill health), or because of an unfavorable shift in her exchange entitlement (e.g. loss of employment, fall in wages, rise in food prices, drop in the price of goods and service she sells, decline in self employed production) (Dreze and Sen, 1988).

To assess risk of entitlement failure or susceptibility to food insecurity the best way is to calculate the ratio of expenditure on non-food items to the expenditure on food items, in fact the non-food expenditures are acting as buffer this means when there is a rise in food prices or decline in income of households or individuals the expenditure on non-food items can be diverted to food expenditure and protect person food entitlement.

Rich people have little to fear from hunger, this is a simple consequence of Engel's law; consumers have a substantial buffer of non-food expenditures to rely on, even if food prices rise sharply. Without the buffer of Engle's law, poor consumers are exposed to routine hunger and vulnerability to shocks that set off famine.

To reach to a clear picture in regards to risk factor attached to food security status of households or individuals in India, the ratio of non-food to food expenditure (buffer of non-food expenditure) calculated from different NSS Rounds for rural and urban areas separately (Table 4).

Table 4: Percentage Expenditure on Non-Food Items to Food Items in Different National Sample Survey Rounds.

	50th round	*51st round*	*52nd round*	*53rd round*	*54th round*	*55th round*
Urban (Percentage of expenditure on Non-Food to Food Expenditure)						
Non-Food/Food	83.2	87.45	100	101.56	101.17	108.09
Rural (Percentage of expenditure on Non-Food to Food Expenditure)						
Non-Food/Food	58.43	64.40	68.84	70.25	64.65	68.31

Source: Author's calculation from different NSS rounds

The risk levels has been classified into 5 different levels including:

- **Very High Risk:** Ratio of non-food expenditure to food expenditure is between 0% - 25%, that means individual or household can tolerate up to 25% increase in food prices or fall in his or her real income without using a severe coping strategy as he/she can divert expenditure on non-food items which are 0% - 25% of expenditure on food items to food expenditure. As this ratio is very small the household/individual can be branded, as being at a very high risk as far as food security is concern.

- **High Risk:** Household/individual can tolerate 25-50 percent rise in prices of food items without using a severe coping strategy as he/she has the non-food/food expenditure ratio of 25% - 50%.

- **Risk:** Household/individual can tolerate 50% - 75% rise in prices of food items without using a severe coping strategy as he/she has the non-food/food expenditure ratio of 50% - 75%.
- **Moderate Risk:** Household/individual can bear 75% - 100% rise in prices of food items without using a severe coping strategy as he/she has the non-food/food expenditure ratio of 75% - 100%.
- **No Risk:** Consumers in this category can tolerate increase in food prices of 100 percent and above as the ratio of non-food to food expenditure for them is above 100 percent which means consumers can stand even a situation when food prices are increased more than double.

In aggregate level the calculated non-food to food expenses ratio from 50th to 55th round of National Sample Survey shows that in rural areas people are facing a risky situation in regards to their food security condition (Table 5).

Table 5: Food Security Risk Assessment in Rural Areas.

	Very high risk	*High risk*	*Risk*	*Moderate risk*	*No risk*
50^{th} round			+		
51^{st} round			+		
52^{nd} round			+		
53^{rd} round			+		
54^{th} round			+		
55^{th} round			+		

50^{th} round: July 1993 – June 1994

51^{st} round: July 1994 – June 1995

52^{nd} round: July 1995 – June 1996

53^{rd} round: January 1997 – December 1997

54^{th} round: January 1998 – June 1998

55^{th} round: July 1999 – December 1999

In urban areas situation is much more better, calculated ratios of non-food to food expenditure indicate that while situation on 50^{th} and 51^{st} round of National Sample Survey can be branded as moderately at risk, it has improved to no risk after 52^{nd} round of National Sample Survey (Table 6).

Table 6: Food Security Risk Assessment in Urban Areas

	Very high risk	*High risk*	*Risk*	*Moderate risk*	*No risk*
50th round				+	
51st round				+	
52nd round					+
53rd round					+
54th round					+
55th round					+

50th round: July 1993 – June 1994
51st round: July 1994 – June 1995
52nd round: July 1995 – June 1996
53rd round: January 1997 – December 1997
54th round: January 1998 – June 1998
55th round: July 1999 – December 1999

But using aggregate data may lead to misinterpretation, as they may paint better picture as far as risk of entitlement failure is concerned. To overcome this problem the ratio of non-food to food expenditure for different Monthly per Capita Expenditure Classes for rural and urban areas calculated separately and then each monthly expenditure class, classified in its respected risk level (Table 7).

Table 7: Ratio of Non-Food to Food Expenditure for Different Monthly Per Capita Expenditure Classes in Urban and Rural Areas.

MPCE classes	*Urban*			*Rural*			
	Expenditure on food items	*Expenditure on non-food items*	*Ratio of non-food to food expenditure*	*MPCE classes*	*Expenditure on food items*	*Expenditure on non-food items*	*Ratio of non-food to food expenditure*
0-300	164.94	89.59	54.30	0-225	128.58	62.27	48.43
300-350	207.11	119.25	57.57	225-255	161.37	80.27	49.74
350-425	240.41	148.61	61.81	255-300	183.87	94.68	51.49
425-500	278.18	185.58	66.71	300-340	207.94	112.85	54.27
500-575	308.97	228.04	73.80	340-380	233.41	127.2	54.50
575-665	348.72	269.77	77.36	380-420	255.09	144.61	56.70
665-775	388.19	330.3	85.09	420-470	279.58	165.39	59.16
775-915	435.34	405.01	93.03	470-525	306.37	190.26	62.10
915-1120	497.95	511.41	102.70	525-615	341.796	224.74	65.75
1120-1500	583.87	702.12	120.25	615-775	395.14	290.61	73.55
1500-1925	696.84	955.31	142.83	775-950	465.59	385.69	82.84
1925 & more	975.44	2099.48	215.23	950 & more	622.03	721.74	116.03

Source: NSS report No. 454: Household consumer expenditure in India, July 1999 – June 2000 key results

Table 7, specifies that in both rural and urban areas as expenditure (income) increases, the ratio of non-food to food expenditure increases. This is despite the fact that both expenditure on food and non-food items demonstrate increasing trends, in other words as income increases expenditure on non-food items increases at faster rate than increase in food expenditure in both rural and urban areas. Table 8 shows the risk level for each Monthly Per Capita Expenditure Class in urban areas.

Table 8: Risk Level for Different Monthly Per Capita Expenditure Classes in Urban Areas.

MPCE	*Very high risk*	*High risk*	*Risk*	*Moderate risk*	*No risk*	*% of consumers in each MPCE*
0-300			+			5
300-350			+			5.1
350-425			+			9.6
425-500			+			10.1
500-575			+			9.9
575-665				+		10
665-775				+		10.1
775-915				+		10
915-1120					+	10
1120-1500					+	10.1
1500-1925					+	5
1925 & more					+	5

Table 8 also indicates that 39.7 percent of urban consumers are at risk of losing their entitlement, 30.1 percent are at moderate risk and 30.1 percent are risk free consumers.

In rural areas situation is quite different, 10.1% of consumers are at high risk of losing their food entitlement even in case of a moderate increase in prices of food consumed by them, 78.8% are at lesser risk as they can tolerate somewhat higher increase in prices of their food basket without using a harsh coping strategy, 5% are at moderate risk as they can stand 82% increase in price of their food basket. Finally, in rural areas there are only 5% of people who could be branded as risk free consumers, because they have enough buffer (in form of non-food expenditure) that would help them to maintain same level of food consumption even if prices of their food basket increases by more than 100 percent (Table 9).

Table 9: Risk Level For Different Monthly Per Capita Expenditure Classes in Rural Areas.

MPCE	*Very high risk*	*High risk*	*Risk*	*Moderate risk*	*No risk*	*%age of consumers in each MPCE*
0-225		+				5.1
225-255		+				5
255-300			+			10.1
300-340			+			10
340-380			+			10.3
380-420			+			9.7
420-470			+			10.2
470-525			+			9.3
525-615			+			10.3
615-775			+			9.9
775-950				+		5
950 & more					+	5

Dealing with Risk:

The risk of entitlement failure can originates from different sources and effectiveness of actions in dealing with risk in the short-run and long run can vary. For example a program, that raises yields of food crops may not have much of an effect on household food security in the short run, whereas a short term feeding scheme on its own may not have much of an effect in the long run. Table 10, links food security risks with different type of policies and programs.

Table 10: Food Security Risks and Policy Choices

Policy choices	*Crop production risk*	*Availability and price risks*	*Employment and income risks*	*Health risks*
Agricultural production policies:				
Technological changes	III	III	III	
Commercialization, diversification	II	II	III	I
Promotion of behavioral change; education	I	II	I	II
Other income and employment generation policies:				
Public works	I	SS, I	SSS, II	
Credits		SS	SSS	S
Macro level policies		SS, II	SS, II	S, I
Food stocks, trade, food aid policies	SSS, I			S
Subsidies and transfer policies:				
Feeding programs		SSS	SSS	SS, II
Food stamp, including transfers		SS	SSS	SI
Food price subsidies; rationing		SS	SS	SI

Source: Von Braun et al, 1992

Note: the extent of positive effects is represented as follows:
I, II, III = some, moderate, high long term impact; andS, SS, SSS = some, moderate, high short-term impact

The following directions can be derived from Table 10:

- Crop production risks are best addressed directly through technological change and commercialization of agriculture in the long run. In situation with high risks for food availability and prices, joint promotion of technological change in staple food and commercialization of agriculture is called for.
- Short term availability and related food prices risks can be addressed through a large array of options, including macro level policies, stockholding, trade, and aid policies, and programs such as public works, provision of consumption credit, food subsidies, feeding program, and income transfers that strengthen the entitlements of food insecure households. Agricultural production policies address these risks in long run.
- Employment and income risks can be tackled in long run through agricultural production policies, and in short run through entitlement strengthening. Labor-intensive public works would have both short and long run risk reduction effects, the latter through creation of assets that generate future income stream.
- Food security policies alone with the exception of those feeding programs that have strong ties to healthcare have only a limited effect on migration or prevention of health risks, which together with food security risks establish nutritional risks. Other policies and programs are needed in conjunction with food security policies. Promotion of behavioral change through nutrition education can have favorable effects for dealing with most of the risk. Long run benefits results from the effects of short-term subsidies on human capital enhancement.

Policy Response for India:

The risk factor related to physical availability and entitlement has been reviewed above. While in case of production and physical availability India faces less variation and consequently less risk during 1990s when compared to 1980s, and 1970s. The food entitlement (economic access) especially in rural areas is faced with high level of risk.

It is necessary to understand that reduced risk at national level (reduction in coefficient of variation in per capita food availability) doesn't translate into reduced risk as far as households and individuals are concerned. The reduced risk of entitlement failure could be achieved through a mix of employment and income policies for the farm and non-farm sectors and trough a minimum safety net.

Moreover, it is necessary to comprehend that chronic hunger is not a food production problem, but a poverty and purchasing power problem. A strategy to provide people a risk free situation with reference to food security boils down on the strategy of shared growth. Shared growth means growth that benefits everyone, that lifts all boats, including that of weaker sections of society. To reduce food insecurity and consequently risk of entitlement failure, the economic manager in India must worry not only about growth itself but also the pattern of growth, and must aim at shared growth. However, managing shared growth and income distribution within a country is the result of initial conditions at some past time and economic and social policies since then. Polices of shared growth over time can make a difference to increase income and its distribution and increase the buffer of non-food expenditure within the poor households which is key to reduce risk of entitlement failure.

In view of heavy dependence of a large proportion of rural population on agriculture for employment and income, the main elements of strategy of shared growth should be based on broad approach toward agriculture and rural development. While the employment effects of technological change in agriculture are often a function of nature of technology and the local labor market conditions, it is possible to visualize that increased production creates demand for additional labor both in the farm and non-farm sectors, partly through multiplier effects of agricultural growth (Mellor, 1986). Since labor households accounts for a large proportion of food insecure population, increased employment opportunities will make substantial contribution towards expanding income and improving their buffer of non-food expenditure which is vital to face risk of entitlement failure arising from increased food prices.

As fragmentation of landholdings and landlessness increase, creation of off farm employment for the rural poor assumes high priority. In the absence of appropriate measures to encourage non-farm activities, a large segment of rural population can not be provided with opportunities for gainful employment, which is necessary to expand their buffer of non-food expenditure.

The typical problem of combined chronic and transitory food security problems in poor households requires a well-designed portfolio of food security policy actions such a portfolio builds on problem assessments, that is, the nature of risks, and on instruments that are available, which are influenced by institutional capacities. Institutional capacity is a precondition not only for monitoring a changing food security situation but also for evaluating the effects of food security policies and programs. Only when the state of food security and its change for the better or worse is transparent will appropriate action be forthcoming. Institutional capacity is also important to facilitate implementation of food security policies and programs. It is imperative that the various institutions involved in this activity be linked. A long-run view of food security improvement needs to be established and institutionalized. Renewed acceleration of agricultural growth with sustainable technology remains a precondition for households and individual food security given high population growth rates, increasingly limited land bases, and dependence on agricultural employment and income by a large proportion of the rural food-insecure population. Otherwise, availability, price, employment, and income risks will accelerate. Reducing fertility to achieve rapid transition to stabilized population through appropriate social, health, and education policies must figure prominently among long-term priorities.

In fine, the human dimension of this problem is such that helping people to help themselves by capacity building can provide a lasting solution. In order to be more effective in risk reduction the food security policy must evolve as a basic element of social security policy with proper coordination among government departments, private sector and non-government organizations. The direct food and nutrition support for the poor through a minimum safety net should be properly balanced with improvements in education, drinking water and sanitation and health care.

Chapter 5

Indian Agriculture, and Food Security: Scene, Scenario and Vision

Indian Agriculture: Scene and Scenario:

In 1798, Thomas Malthus warned humankind about the dire consequences of unchecked population growth. The French mathematician, Marquis de Condorcet, a contemporary of Malthus, pointed out that population would stabilize itself if children were born for happiness and not just for mere existence. Thanks to dramatic advances in preventive and curative medicine, since World War II, human numbers have been increasing at a rapid rate. A billion persons are being added to the human population every 12 to 13 years. When Malthus published his essay in 1798 the global population was 980 million. The population of India alone is now more than 1 billion. In spite of such a rapid rise in population food production has on the whole kept pace with the needs of expanding population during the recent decades. How did this happen?

There are four important factors that have helped to keep Malthusian fears at bay. There are;

- Rapid advances in science and technology. Particularly in the area of breeding new varieties and hybrids of food crops which can respond well to irrigation water and good soil fertility.
- Services like the production and distribution of good seeds, fertilizers and pesticides, as well as the organization of efficient credit and extension services.
- Public policies in the areas of land reform, rural infrastructure development, input and output pricing and marketing, and;

- The hard work of farmers, who have demonstrated that whether they live in industrialized or developing countries, they will respond to technological progress and opportunities for assured and remunerative marketing.

In the late sixties India was categorized as lost case by the authors of "famine 1975", William Paddock and Paul Paddock (1968), went to the extent of suggesting that the 'Triage' principle should be applied to food aid to India. This principle is adopted in military hospitals on the war front and is based on the practice of saving those who can be saved and not wasting limited resources on those who cannot be saved, India was classified under the later category (Dantwala, 1986). Their analysis had convinced them that India would not be able to increase food supplies (through increased production, imports, and food aid) to match its population growth and they had predicted large-scale starvation.

When India's imports of cereals had reached an alarming level in the middle of sixties, a new agricultural strategy was adopted in the country, as a result, the production of food grains in India underwent a radical change from mid sixties onwards, consequently, "in 1968, a several thousand-year-old barrier in the yield of wheat was broken and India achieved a wheat production of 17 million tons. An American scientist Dr. William Gadd called the dramatic breakthrough the Green Revolution" (Economic Times, 5, NOV.1995). The advent of Green Revolution was at a time when the availability of further land had more or less reached its limits, the agriculture scenario changed from one of the land reclamation to one heavy dependent on modern inputs. The introduction and rapid spread of high yielding rice and wheat varieties resulted in steady output growth for food grains. Public investment in irrigation and other rural infrastructure, research and extension, together with improved crop production practices, has significantly helped to expand production and stock of food grain, production, which was 72 million tones in 1965/66, rose to 195 million tones in 2000-01. Imports, which averaged 6 million tons per year from the mid 1960s to mid 1970s, have been negligible in recent years, and in last decade India emerged as a marginal exporter of wheat and rice.

More than Thirty years and a record production of around 200 million tons of food grains, the country seems up against another yield barrier. The concerns are rising from the fact that public investment in agriculture has failed to pick up and intensive input use has degraded the ecology. While the government rejoices over a record food grain production, there are doubts about the country's ability to produce enough to meet demand by 2020. The pessimistic projections of India's ability to meet future production targets arise from environmental issues and problem of resources, India does not have enough resources to invest in degraded land, conservation of forests and research. As a result, yield growth rates of food grains are stagnating in most part of the country. The productivity of soil started declining. The underground water table is depleting at a high rate, which in the medium term can cause production of grains which are water intensive, to fall. There is also the fear that future production will be affected by the farmer's tendency to switch to cash crops or give fertile land over for non-farm development.

In the years to come, higher economic growth, as well as, sizeable population growth will increase demand for food. The structure of demand is also changing, as diet diversifying from the basic cereal staple to fruits, vegetable and other higher valued foods. These involving scenarios will change the supply and demand prospects in the next century. What then are prospects for India's trade in food? Will India become either a big importer or exporter?

Some Structural Characteristics of Indian Agriculture Sector:

The study of agricultural sector in India divulges several structural characteristics of the sector, these include:

i) There are 105.3 million farm holdings with an average size of 1.57 hectares. 59 percent of holdings are below one hectare in size and 19 percent holdings operate one to two hectares of land most of these can not provide a reasonable living to an average family.

ii) Irrigation facilities are available to only 35 percent of net sown area, which limits the possibilities of double, or multiple cropping. The productivity of un-irrigated land is less than half of irrigated lands. Further, the productivity and production on un-irrigated areas are subjected to wide inter year fluctuations resulting in unstable income to the dependent families.

iii) Irrigation sector was given special attention in Indian plans and as a result the irrigated area in the country went up from 38 million hectares in 1970-71 to 80.7 million hectares in 1996-97 showing an annual increase of 1.65 million hectares.

iv) Agriculture sector is the most privatized sector in India. Decision on what, how much, when and how to produce and sell are taken by individual farmers, who are free to chose among alternatives. Government policy is essentially directed at increasing these alternatives and influencing the decision of farmers in making choice.

v) The cropping system in the country continues to be dominated by cereals. The shares of different groups in the gross crop area are cereals 53.1%, pulses 12.7%, oilseeds 15%, Cotton 4.8%, fruits and vegetables 4.0%, sugarcane 2.3%, spices 1.4%, and others 6.7%.

vi) There has been considerable increase in fertilizer use and mechanization and in agriculture during the last four decades as is evident from the following:

Table 1: Fertilizer Use and Mechanization in Indian Agriculture.

Particular	*Units*	*1951-52*	*1996-97*
Fertilizer Use	Kg/ha	1	75
Tractors (No's)	'000	9	1760
Electric Pumps (No's)	'000	21	9620
Diesel Pumps (No's)	'000	66	5200

Source: Acharya, 2000.

Features of Existing Agricultural Policies:

The existing policy framework for agriculture is the outcome of many years' experimentation. The evolution of policy and current policy framework can easily be discerned from the changes in objectives.

The strategic objectives of agricultural development in India and changes there can be identified as follows:

Box 1: Objectives of Agricultural Development Policy in India

Period	**Strategic Objective**
Before independence up to mid sixties	To keep prices of food grains low
Mid sixties to early eighties	Maximizing production of food grains
Early eighties to early nineties	Evolving production pattern according to demand pattern
Since early nineties	Slow opening up of trade in agricultural commodities

Source: Acharya, 2000.

Several policy instruments for achieving the above set of objectives have been tried and used in India. The instruments, which are currently in use, include the following:

i) Fixation and announcement of minimum support prices for 24 commodities before sowing and making arrangements for purchases of farm produce at these prices in case market prices dip below these levels;

ii) Selective intervention in the market for some commodities under market intervention scheme of Government of India.

iii) Open market operation by public agencies and cooperatives for some commodities like raw cotton, oilseeds and copra;

iv) Buffer stocking of food grains specially wheat and rice;

v) Public distribution of certain commodities like wheat and rice at subsidized price;

vi) Levy on rice mills and sugar factories and distribution of levy sugar at subsidized prices;

vii) Imposition of stock limits on traders and processors;

viii) Regulation of marketing practices in agricultural produce markets;

ix) Prescribing quality and grade standards of agricultural products;

x) Creation of infrastructure facilities for improving marketing such as market yards and sub-yards in primary produce markets, roads, communication facilities and dissemination of market information;

xi) Encouraging cooperatives in agricultural development and marketing

xii) Regulation of exports and imports.

PAST GROWTH, COMING CONSTRAINTS

Accounting for Past Growth:

Sustained growth in agricultural productivity is critical to improve food security for two reasons. First, growth in agricultural productivity translates into increased food supplies and lowers food prices for consumers. Second, growth in agricultural productivity means higher incomes and thus improved ability to purchase food and other basic necessities, for many food insecure people who earn their livelihoods through agricultural production

(USDA, 2000). For example in case of India "rapid growth in wheat and rice production has resulted in substantial increases in the marketable surplus of wheat and rice. These have contributed to food security mainly by including sharp declines in real prices of rice (down 2.2 percent annually) and wheat (down 3.3 percent annually)"(Kumar, 1995).

Agricultural productivity in turn, depends on a variety of factors. Recent studies (e.g. Craig, Pardey, and Roseboom, 1997 and Frisvold and Ingram, 1995) indicates that most differences in agricultural productivity, whether across household or countries or overtime, can be attributed to differences in the quantity of conventional inputs used in agricultural production, such as land, labor, fertilizer, and machinery but agricultural productivity also depends critically on the quality of inputs used, including the quality of natural resources such as land (USDA, 2000).

The period between 1947and 1966 went through three major steps in agricultural planning and development in India. In the first phase from 1947 to 1960 emphasis was given to development of infrastructure such as, rural roads, irrigation projects schools, hospitals, and manufacturing of mineral fertilizers, the second phase from 1960 to 1965 saw the introduction of an Intensive Agricultural District Program (IADP). Unfortunately, the result during first few years of this project were disappointing because it was soon found that the "package" lacked genetic strains that could respond effectively to irrigation and fertilizer application. Thus, This deficiency in the package program was resolved in 1966 (third phase) when High-Yielding Varieties Program (HYVP) in wheat, rice, Maize, sorghum, and pearl millet was introduced. The wheat revolution was first to occur (Swaminathan, 1996). In 1968 India achieved the production of 17 million tons of wheat. Dr William Gaud, Director of US Agency for International Development (USAID) called the dramatic breakthrough the Green Revolution. India's share of achievements, says Dr. M.S. Swaminathan (Swaminathan 1998), can be judged from the fact that gains of 7 million tons between 1964 and 1968 alone, when high yielding wheat varieties (HYVs) were first introduced, exceeded that of 4000 years history of wheat cultivation in India.

The growth in food grain production over the past has mostly been benefited by wheat and rice of 113.9 million tons gain in food grain production between 1960-61 to 2000-01, share of wheat, and rice was 57.7 and 50.3 million tons respectively (wheat 50% followed by rice 43%). Thus, rice and wheat, classified as fine cereals and aptly described as the Green Revolution crops, two together sliced around 95% increase.

Since independence, gain in net food grain production has been to the tune of around 130 million tons (Table 2).

Table 2: Net Production of Food Grain In India 1951-2000.

Year	*Production*	*Year*	*Production*	*Year*	*Production*	*Year*	*Production*	*Year*	*Production*
1951	48.1	1961	72	1971	94.9	1981	113.4	1991	154.3
1952	48.7	1962	72.1	1972	92	1982	116.6	1992	147.3
1953	54.1	1963	70.3	1973	84.9	1983	113.3	1993	157.5
1954	63.3	1964	70.6	1974	91.6	1984	133.3	1994	161.2
1955	61.9	1965	78.2	1975	87.4	1985	127.4	1995	167.6
1956	60.7	1966	63.3	1976	105.9	1986	131.6	1996	157.9
1957	63.4	1967	65	1977	97.3	1987	125.5	1997	174.5
1958	58.3	1968	83.2	1978	110.6	1988	122.8	1998	168.2
1959	69	1969	82.3	1979	115.4	1989	148.7	1999	178.2
1960	67.5	1970	87.1	1980	96	1990	149.7	2000	182.8

Source: Indian Economic Survey 2001-2002.

Of this 30 million tons increase in food grain output happened in the period of 1951-65 (Pre Green Revolution), and the growth of almost 100 million tons after that and up to now (Post Green Revolution era). However, increase in food grain output, during the pre Green Revolution era was contributed both by expansion in area and rise in yield. In contrast, the output growth following Green Revolution was due primarily to improvement in yield (Table 3).

Table 3: Annual Growth Rates in Food Grain Production, Area, and Yield During Pre and Post Green Revolution Era

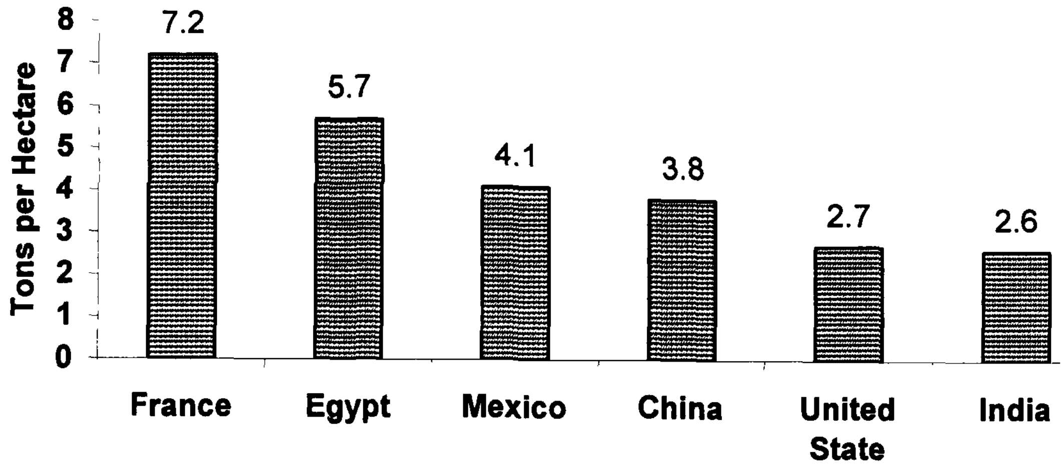
	Area	*Production*	*Yield*
1949-50 to 1964-65 (pre Green Revolution era)	1.35	2.82	1.36
1967-68 to 1996-97 (Post Green Revolution era)	0.42	2.62	2.62

Source: Government of India, 1998.

Several studies agree on this analysis (vidyanathan 1993, Hanumantha Rao 1994, Ramakrishna 1993, Ahluwalia 1995, and Katyal et al, 1997).

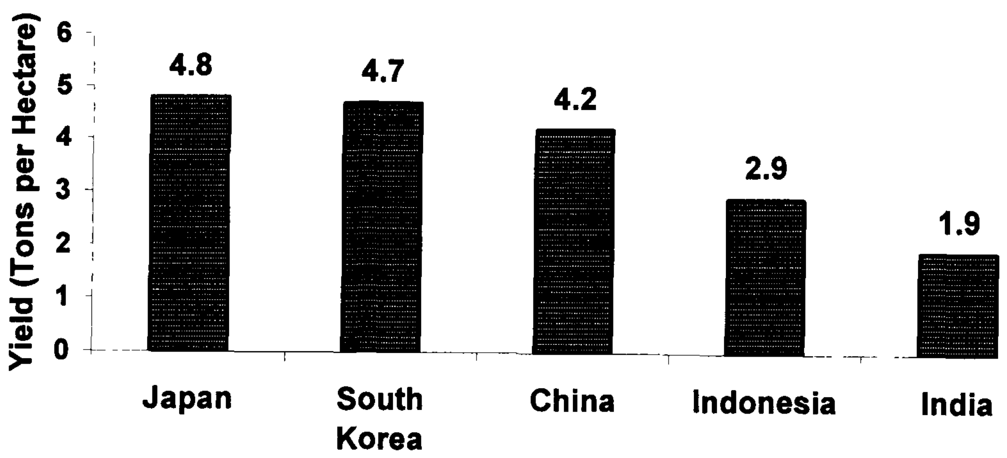
Despite this impressive performance of Indian agriculture in absolute terms when compared with the levels achieved in other countries shows how low the productivity in India agriculture is. Such exercise has been attempted in Figures 1,2.

Figure 1: Yield of Wheat in Major Producing Countries (Tons Per Hectare)



Source: World Watch 1999, and 1997.

Figure 2: Yield of Rice in Major Producing Countries.



Source: United States Department of Agriculture (USDA), 1999

As it is clear from figure 1 and 2 the productivity of wheat in India is almost one third of the France and United Kingdom, half of the Egypt, 30 percent less than china, and 76 percent less than Mexico.

As far as rice is concerned the productivity is almost 40 percent of Japan and South Korea, and 47 percent of that of China, and 65 percent of Indonesia's productivity.

Recent Trends in Production Growth Rate:

During the nineties, the rise in grain land productivity in India was slowed as it is in many other countries. Calculating the annual compound growth rate from food grains production records shows that the 1980s had the highest rate of increase of past three decades (period of Green Revolution), at an average 3.54 percent per annum, this was followed by slower growth rate of 1.8 percent per annum during the 1990s, in fact 1990s was the worse decade for growth rate of production of food grains in India during its 50 years of independence (Table: 4).

Table 4: Annual Growth Rate of Production of Food Grains (Index Based)
(Based Triennium Ending 1981-82=100)

Crop	*1967-68 to 1979-80*	*1979-80 to 1989-90*	*1989-90 to 1998-99*
Rice	1.99	4.29	1.60
Wheat	5.68	4.24	3.62
Coarse Cereals	0.67	1.74	-0.48
Total Cereals	2.7	3.63	1.88
Pulses	-0.44	2.78	1.19
Food Grains	2.02	3.54	1.80

Source: Economic Survey (1999-2000).

Data available for the Kharif-Rabi split up of total production indicate that the Kharif production has been more severely affected than the Rabi production. The growth rate of Kharif food grain production has declined from 2.23 percent in the 1980s to 0.66 percent per annum in the 1990s. Though growth rate of Rabi food grains production had also experienced a decline during this period it was at a much smaller level a reduction from 3.33 percent in the 1980s, to 3.12 percent in the 1990s.

The decline in the Kharif production growth rate has been influenced by the decline in both area and yield. Though the area of Kharif food grains had experienced negative growth rates during both the 1980s and 1990s, the decline was more rapid during the 1990s. Further the yield growth rate declined from 2.04 percent during the 1980s to 1.80 percent per annum during the 1990s. However, during the Rabi season, due to the increased growth rate of area under food grains, the decline was mainly on account of the decline in the yield growth rate from 3.20 percent during the 1980s to 1.60 percent per annum during the 1990s. The influence of negative growth rate in the area under Kharif food grains dominated the positive growth during the Rabi season during the 1980s and 1990s, so that there has been a negative growth rate in the combined area under food grains for Kharif and Rabi (Table 5).

Table 5: Growth Rates of Area, Yield and Production of Food Grains in India: Season-wise (Percent Per Annum)

Season	*1970s*	*1980s*	*1990s*
Kharif			
Area	-	-0.40	-1.13
Yield	-	2.64	1.80
Production	-	2.23	0.66
Rabi			
Area	-	0.14	1.39
Yield	-	3.20	1.60
Production	-	3.33	3.12
Kharif+Rabi			
Area	0.46	-0.23	-0.24
Yield	1.50	2.93	2.07
Production	1.96	2.70	1.84

Source: Author's Calculation.

The causes of fall in production growth rate during the 1990s lays on both financial and environmental problems. In fact, environmental problems to great extent are outcomes of financial problems. As mentioned in earlier parts of this chapter India does not have enough resources to invest in its degraded land.

Financial Problems:

Public investment in agriculture contributed to the dramatic improvement in India's food security situation since the mid 1960s and to a steady decline in rural poverty. Public investment affects agricultural growth and poverty alleviation in future also, these include the direct benefits the poor receive from spending on rural development programs, such as employment programs targeted directly to them. It also includes indirect effects that arise when government invests in rural infrastructure, agricultural research, and the health and education of rural people, since these investments stimulate both agricultural and non agricultural growth, lead to greater employment and income earning opportunities for the poor and reduce the cost of food.

International Food Policy Research Institute (IFPRI), in a 1999 research report entitled "linkage between government spending, growth, and poverty in rural India", ranked government expenditure according to their effectiveness, the results are striking.

Government expenditure on roads has by far the largest impact on rural poverty as this type of investment not only reduces rural poverty through productivity growth, but also through increased nonagricultural employment opportunities and higher wages. Productivity growth accounts for 24 percent of the total impact on poverty, nonagricultural employment accounts for 45 percent, and increase in rural wages account for the remaining 31 percent. Of the total productivity effect on poverty, 75 percent arises from the direct impact of roads on incomes, while the remaining 25 percent arises from lower agricultural prices (15 percent) and increased wages (10 percent). Government investment in research and extension has the second largest impact on rural poverty, but the largest impact of any investment on productivity growth. R & D has a smaller impact on poverty than roads because it only affects poverty through improved productivity, and India has not targeted R & D specifically to improve the lot of the poor. If future agricultural research and extension were more deliberately targeted to the poor, it might well have a greater impact on poverty. Government expenditure on irrigation has third largest impact on productivity growth; an additional Rs. I billion expenditure would add 0.56 percent to the growth rate. Public investment in irrigation plays catalytic role in stimulating additional private investment in irrigation (Fan et al, 1999).

Despite all these well-documented impacts of public sector investment on agricultural productivity, and poverty in the 1990s, the public investments in agriculture started to decline; the annual increment to gross capital formation in agriculture is now lower than 1980s. This decline seems to be happening in all states in India, not just the poorest ones, At the same time increasing share of total public expenditure on agriculture are allocated to input subsidies (on fertilizers, electricity, irrigation, and credit, for example), rather than to productivity-enhancing investments such as research. The share of input subsidies in public expenditure increased from 44 percent in the early 1980s to 83 percent by 1990. Private investment in agriculture has increased modestly (Table 6) in recent years, but not by enough to fill the gap left by the decrease in public spending (Kumar et al, 1995).

Table 6: Public and Private Investment in Agriculture, 1993-2000

Year	*Private*	*Public*	*Total*	*Percentage of public investment to total investment*
1993-94	9056	4467	13523	33
1994-95	10022	4974	14996	33
1995-96	10842	4848	15690	30.89
1996-97	11508	4668	16176	28.86
1997-98	11974	3979	15953	24.94
1998-99	12538	3846	16384	23.47
1999-00	13988	4668	18656	25.02

Source: Indian Economic survey, 2000-01.

Although private investment in agriculture was stepped up in 1990s in response to the liberalization of the economy and favorable terms of trade, real public investment continued to decline on account of fiscal compression and the failure to reduce input subsidies. As a result, the development of infrastructure like irrigation, rural electrification, roads, and markets has been a major causality (Hanumantha Rao, 2001). As the mid term appraisal of the Ninth Five Year Plan points out, "there are strong complementarities between public and private investments, and inadequate public investment could lead to a 25 percent lower private investment than desired. "This lack of investment especially in rural infrastructure and in development of new agricultural technologies hinders the ability of producers to respond to the market and, therefore, decreases the prospects of overall agricultural growth" (Resurgent and Malik, 1995).

Further, the combined expenditure by the centre and state governments on agricultural research and education, which is the most important determinant of TFP in agriculture stagnated around 0.5 percent of agricultural GDP over this period (Pal, Jha and Singh 1997), as against the requirement of 1 percent by the Indian Council of Agricultural Research for the Ninth Five Year Plan.

Environmental Problems:

Mutually reinforcing packages of technology, services and public policies led to the birth of what was termed as Green Revolution. It led also to the birth of environmental problem in Indian agriculture scene and scenario.

Environmental problems of Indian agriculture are due the fact that, at the time Green

Revolution was adopted, sustainability was not the criteria. The only way out was to pump in inputs so that production rises. It was a strong reductionism strategy not a total one. It was not sustainable. It did not incorporate forward and backward linkage. Furthermore it was a Grain Revolution not Green Revolution. Wheat and rice became the king among the crops[1]. These were not traditional varieties. With green revolution came the water thirsty, chemical-intensive hybrid varieties. Even M S Swaminathan, the father of Green Revolution and former director of Indian Agriculture Research Institute, New Delhi, had warned the danger when Green Revolution was adopted. Addressing the Indian science congress at Varanasi in January 1968, he has said: 'Exploitive agriculture offers great possibilities if carried out in a scientific way, but poses great danger if carried out with only an immediate profit motive. The emerging exploitive farming community in India should become aware of this. Intensive cultivation of land without conservation of soil fertility and soil structure would lead, ultimately, to the springing up of deserts. Irrigation without arrangements for drainage would results in soil getting alkaline or saline. Indiscriminate use of pesticides could cause adverse changes in biological balance. Unscientific tapping of water will lead to exhaustion of this wonderful resources left to us through ages of natural farming'. His words were prophetic without management systems, agriculture disaster, rather than prosperity, has taken place in barely three decades.

No other states illustrate the ugly face of Green Revolution more than Punjab; state that

[1] As mentioned by Hopper, 1993, the increased food grains production since 1970 has been made up of almost exclusively of greater production of wheat and rice, while production of coarse grain and pulses changed only marginally Planting of wheat and rice crops is now made up of almost entirely higher

supplies food to almost all the state of India. Unfortunately while trying to feed the rest of the nation Punjab has lost its prime land. Central districts face a desertification threat, while the southwestern districts are swamped in excess water. The state on which the rest of India relies on for food grain is in grate danger. In 1997-98 Punjab and Haryana produced 12.8 percent and 30.6 percent of the total rice and wheat respectively in the country, of the total of 82.5 million tones of rice production. The two states accounted for 10.5 million tons. During the same year, of the total 66.3 million tons wheat production, the two states accounted for 20.3 million tons. Their contribution to the Central Food Pool, particularly wheat and rice also cannot be undermined. In 1999-2000 (up to July), these states were providing 49 percent and 82 percent of the total rice and wheat, respectively to the Central Food Pool. Unfortunately, the growth rate in productivity of rice and wheat has registered a decline in most of the district in Punjab and Haryana. From a state average of 8.97 percent during 1965-74, rice productivity declined rapidly to 2 percent in the mid 1980s. In the last decade there was only 1 percent increase per year, says a 1998 report, decline in crop productivity in Haryana and Punjab: Myth or Reality? By the Indian Council of Agricultural Research (ICAR) New Delhi. Ludhiana and Ropar (key Green Revolution districts) have now negative growth rates the reports states. Meanwhile, the growth rate of wheat was almost 5 percent in the late 1960s has come to 3.5 percent in the late 1980s and 2 percent in the last decade.

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yielding varieties, and between them account for almost two-thirds of all fertilizers consumed in agriculture This can largely be attributed to government interventions that heavily subsidized wheat and rice production, almost to the exclusion of other crops

FUTURE CHALLENGES

I. Demand for Food Grains by 2020:

Food grain demand have been constructed variously by counting for the additional needs generated by one or more than one of the following elements: population growth, changing food habits (dietary patterns), seed and feed needs, buffer stock building, export/import, and wastage.

Starting from Malthus, the question of feeding the ever-growing population has been engaging the attention of politicians and academicians alike – At the international level the history of global carrying capacity estimates goes a century back. Nobody could make reliable global appraisals until there was at least basic information regarding the extent of cultivated and potentially cultivable area, typical yields of dominant cereal crops, and their likely future increase. As with so many other developments, the time for projecting the total population that plant can support came during the last decades of the 19^{th} century. Ravenstein (1891), perhaps the first researcher to investigate the limit, came up with a maximum total of just under 6 billion people. Shortly afterward, Pfaundler (1902) assuming no extension of the then existing 2,174 million hectares of crop land and good grazing land, average density of people per hectare supported by traditional farming methods, and recycling of organic matter-ended up with a minimum of 11 billion people. Numerous other estimates followed, and those vary from 10 to 40 billion people (Brown, 1954).

The position is more or less the same in India. Demand projections were varying widely even within a short period to the year 2000 (Table7).

Table 7: Comparison of Studies for Demand Projections for Food Grains in 2000 A.D.

	Studies	*Human demand*	*Domestic demand (million tons)*
1.	National Commission on Agriculture, 1976		205-225
2.	Working Groups (Requirement) Demand at physiological level	Food grains Food grains	179 219
3.	World Bank, 1981		191-205
4.	IFPRI study (for Asian Development Bank) 1984		210
5.	Planning Commission, 1985		240
6.	Radhakrishan and Ravi, 1990. Centre for Economic and Social Studies, Hyderabad, India	205[b]	234[c]
7.	G.S. Bhalla	Food grains	263
8.	Radhakrishna and Ravi 1994	Food grains	230.22
9.	Sharma and Gandhi	176[a]	220[c]
10.	IFPRI, 1990	183[b]	227[c]
11.	P.C. Bansi, 1996		198[d]
12.	Parduman Kumar, 1996	182[b]	209[e]
13.	IARI-IFPRI Study		205[c]

a. without change in income distribution
b. With change in income distribution
c. Projected the requirements for sees, feed, industrial use and waste. Feed demand is computed using the feeding ratio (that is, the quantity of feed required to produce one unit of livestock products)
d. Using incremental demand model by providing additional requirement for household and non-household over the base year demand
e. Using a grassing factor of 1.143 to account for non-household demand

Source: Agricultural development paradigm for the ninth plan under new economic environment, by Bhupat M. Desai.

The position is all the more complicated for the year 2020. ICMR (Indian Council of Medical Research) estimated that in 2020 food grains requirements would stand at 375 million tons. Kumar (1998), while dividing the population into rural and urban livings, sub-classified them further into four expenditure groups i.e. very poor, moderately poor, non-poor lower, and non-poor higher. Aggregate calories needs (at 5% GDP growth rate) translated into food grains equivalent of 181 million tons for the year 2000 and 262 million tons for the year 2020 (Table 8).

Table 10: Projected Direct Demand (at 5% GDP) for Food Grains in India

Crops	*2000*	*2020*
Rice	82	117
Wheat	62	93
Coarse grain	23	28
Pulses	14	24
Total Food Grain	181	262

Source: Kumar 1998.

Apart from the direct needs to fulfill human demand for food, there are some collateral requirements which necessitate inclusion to arrive at total food grains (Kumar, 1998), these constitute seed need, feed needs, and wastage with no major shift foreseen for area under food grains in future, seed needs have been calculated to be around 4.4 million tons by the year 2020 (Table 9).

Table 9: Projected Indirect Demand (mt) for Food Grain in India.

Crops	*Seed*		*Feed Grain*		*Industrial use*		*Wastage*	
	2000	2020	2000	2020	2000	2020	2000	2020
Rice	1.28	1.28	0.44	0.86	2.01	2.62	1.23	2.10
Wheat	1.79	1.79	2.14	4.20	2.01	2.62	1.98	3.06
Coarse grain	0.55	0.55	5.15	10.13	0.65	0.85	1.73	2.26
Pulses	1.20	1.20	0.86	1.69	0.33	0.46	0.35	0.48
Total Food Grain	4.40	4.40	8.59	16.88	5.00	6.55	5.29	7.90

Source: Kumar, 1998.

By summing up the direct and indirect food needs, the aggregate food grain demand (direct + indirect food grain needs) works out to about 200 million tons in 2000 and 294 million tons in 2020 (these calculations correspond to a median GDP growth rate of 5%).

Sinha (1999) basing his estimates on 2,500 calories/person/day assuming only 1,400 Calories will come from food grains, reported that India will need 152 million tons of food grains for direct human consumption for a population of 1150 million and 172 million tons for population of 1300 million in 2020. However, in his calculations around 1,100 calories are to be derived from milk, vegetables, fruits, sugar, vegetable oil, and root and tuber crops. Assuming a 30% requirement of direct food grain needs on seed, feed, wastage etc. Sinha (1999) project a maximum requirement of 260 million tons by 2020.

In the calculations of Katyal (1997), there will be need of around 266 million tons of food grains for the year 2020.

Parikh and Dev (1995) forecasted cereal grain demands for India by building their calculations on two extreme scenarios: (1) Moderately rapid population growth and relatively slow growth of national income (3.75%) (MP-LG) and (2) Relatively high population growth and high national income growth (6.75%) (HP-HG). Human consumption demand for cereals (equivalent to direct needs) with the criteria of Parikh and Dev (1995) works out to MP-LG 189 million tons (wheat 65 million tons, rice 97 million tons, Coarse Cereal 27 million tons) and Hp-Hg 235 million tons (wheat 100 million tons, rice 109 million tons, and coarse cereals 26 million tons). If the projected demand on pulses at 24 million tons is added up, the total food grains requirements of 259 million tons almost equals to that made by Kumar (1998).

Bansil (1998) estimated food grain demand of 283.88 million tons by the year 2020 (Table 10).

Table 10: Demand for Food Grains 2020

	Population (million)		
Item	Urban	Rural	Total
1993	221	663	884
2020	544	816	1360
1993-2020	323	153	476
Additional food grain requirement (million tons)			
Human Consumption			
Cereals	42.6	25.7	68.3
Pulses			7.2
Milk (additional 73 million tons)			17.5
Eggs (additional 97 billion eggs)			5.8
Chicken (additional 4.4 million tons)			5.3
Other meat			2.0
Draught and other animals			3.5
Wastage			1.5
Industrial uses			0.5
Total additional requirement			111.60
Total quantity available in the system during 1993			172.28
Grand total (Demand by 2020)			283.88

Source: Bansil, 1998

Starting from 1993 as base (with total availability of 172.28 million tons), Bansil (1998) assumed that the population of India by 2020 would be 1360 million, of which 544 million (40%) will be urban and the rest as rural. He further assumed that human consumption for both rural and urban India would remain constants at the levels of 14 kg Per Capita per month (rural) and 11 kg per capita per month (urban). He further calculated food grain requirement of 17.5 million tons for production of additional 73 million tons of milk (6 kg food grain equal to 1 kg milk), 5.8 million tons for production of additional 97 billion eggs, 5.3 million tons for production of additional 4.4 million tons of broiler meat (at rate of 1.2 kg food grain for 1 kg of meat) and 2 million tons of food grain to produce other types of meat. He assumed demand for feeding drought animals at 3.5 million tons, another 1.5 million tons for wastage, and industrial uses 0.5 million tons. According to him as there is no possibility for expansion of area under production there would be no increase in seed requirement for the year 2020 over the year 1993.

International Food Policy Research Institute's International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) provides cereal demand for India and several other countries according to IMPACT projection, demand for cereal in India by the year 2020 will touch the level of 304.32 million tons (Table 11).

Table 11: Demand for Cereal in India 1990-2020

Commodity	*1990*	*2020*
Wheat	47.89	95.62
Rice	74.76	144.79
Maize	8.97	16.39
Other coarse grains	27.47	47.51
Total cereals	159.08	304.32

Source: Rosegrant, et al, 1995

Bhalla et al. 1999 projected cereal demand for India in the year 2020 under different scenarios. They projected cereal requirements under different income growth scenarios (2%, 3.7% and 6%) (Table 12).

They projected demand for cereal to feed for livestock assuming that 1.2 kg of cereals is required to produce 1 kg of meat equivalent (meat and eggs are weighted at 1 and milk at 0.1). This led to the 2020 food and feed projections in Table 12.

Table 12: Projected Total Cereal Requirements for India 2020

	Food	***Feed***	***Total***
2020 projection with per capita income growth of:			
2 percent	231.51	25.75	257.26
3.7 percent	246.08	50.11	296.19
6 percent	267.21	107.52	374.73

Source: Bhalla et al, 1999.

Most of the projections listed above are based on calculation of demand elasticities and making assumption about Per Capita income growth rate. But, the uncertainties in economic scene and scenario in most of the developing countries specially India and irregular behavior of demand elasticities for food over long period of time makes it impossible to project accurate food demand for a long time period correctly. Moreover at the best they can measure only the effective demand for food and not the required food to provide a minimum measure of food security to the society.

To overcome these shortcomings in demand projections, based on the definition of food security a well-fed India scenario is developed to project the actual food needs to achieve food and nutritional security in the year 2020. This scenario based on the recommended food items by the ICMR (Indian Council of Medical research) and population projection in 2020 (Table 13).

Table 13: 2020 Food Demand Projection Based on the Definition of Food Security

Food item	*ICMR norm (grams/ person/ day)*	*2020 well-fed India scenario for Population 1272.167 Million*	*2020 well-fed India scenario for Population of 1329.1 Million*	*2020 well-fed India scenario for Population of 1420 Million*
Cereals as food	400	185.74	194.05	207.32
Cereals as feed		23.03	34.36	25.72
Pulses	41.34	19.20	20.05	21.47
Total food grains as food and feed		227.97	248.66	254.51
7.5% seed & waste		17.10	18.65	19.10
Total food grains requirements in 2020		245.07	267.31	273.61
Milk	227.00	105.41	110.12	117.65
Meat	11.42	5.30	5.54	5.92
Eggs	7.21	3.35	3.50	3.74
Oils	16.83	7.81	8.16	8.72
Roots	55.58	25.81	27.00	22.32
Sugar	43.06	20.00	20.90	28.81
Soybean	6.83	3.17	3.31	3.54

Source: Author's calculation, based on ICMR (Indian Council of Medical Research) recommended food norms.

Long-term projections involving extreme scenarios (high population growth and low population growth) are helpful in capturing a range of possible alternatives.

Whether population is projected at 1272.167 (FAO), or at 1329.1 (standing committee on population) or 1420 million (Kumar, 1998), total food grains requirement to ensure a well-fed society in India vary between 245 million to 273 million tons. Consequently, the task of raising production between 65 million tons to 90 million tons over the net production level of year 2000 (180 million tons) is challenge for Indian policymakers in the next two decades. To achieve this target while annual production growth rate of 3.5 to 4.5 percent is needed (see also Kumar 1998) the growth rate during 1990s stalemated much behind the desired level at the rate of 1.8 percent (See Indian economic Survey 1999-2000).

Supply Prospect:

The simplest method for projecting future production of cereals in India is to extrapolate past growth trend. Assuming that the total cereals production will continue to grow at the rate of 1990s(1.8 percent), if we take production level of agriculture year 1999-2000 as a base then by the year 2020 the production of cereals in India will reach to the level of 265.88 million tons. But such an extrapolation seems unrealistic, since there would be less and less fund available of for investment in research that is needed to generate technologies and knowledge, which are required to maintain same growth rate in an environmentally stressed situation. Bhalla et al 1999 estimated the cereal production seed and waste requirements and available supply under 8 different scenarios in 2020(Table 14).

Table 14: Alternative Cereals Supply Projections for 2020, India.

Scenario/ Projection basis	Production	Seed and Waste	Available Supply
1993			
Actual	168.6	12.6	156.0
2020			
162/65-93 extrapolated (2.7 percent production growth rate)	347.1	26.0	321.1
Scenario 2			
IMPACT model (baseline)	256.2	19.2	237.0
Scenario 3			
1993 fertilizer use is tripled to an all India average of 334kg/hec (to reach the agronomic optimum scenario)	287.5	21.6	265.9
Scenario 4			
50 percent of gross cultivated area is irrigated (100 percent irrigation potential is achieved)	236.3	17.7	218.16
Scenario 5			
Fertilizer use raises to 334 kg/hec and 50 percent of cultivated area is irrigated (most Optimistic fertilizer and irrigation Scenario	389.6	29.2	360.4
Scenario 6			
Fertilizer use doubles to 227 kg/hec and 41.5 percent cultivated area is irrigated (half of the increase irrigation and fertilizer compared to scenario 5)	279.4	21.0	258.4
Scenario 7			
Fertilizer rises to 50 percent to 173 kg/hec and 41.5 percent of area is irrigated (25 percent of the fertilizer rise and 50 percent of the irrigation rise compared to scenario 5)	251	18.8	232.2
Scenario 8			
Scenario 7 plus genetic and efficiency improvements	281	21.1	259.9

Source: Bhallla et al, 1999.

Rosegrant et al with the help of IFPRI's International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT) projected the annual growth rate of 1.42 percent for all cereals between 1993 to 2020 according to their estimate total cereal production would grow from 168.6 million tons in 1993 to 256.2 million tons in 2020.

Kumar (1998) developed a detailed econometric model of cereal production system in India. He provides two supply scenarios for 2020, one with the accelerating rate of growth in total factor productivity and one with a decelerating in TFP. In the first case, total cereals production in 2020 is estimated at 309 million tons. If growth in total factor productivity slows down, then total production in 2020 will only be 269.9 million tons.

Another scenario, is to assume that the growth rate of production of cereals continues to be 1.88 percent per annum (the growth rate between 1989/90 to 1998/99, as reported by Indian Economic Survey 1999-2000), then the total cereal production in the year 2020 will be 266.02 which is remarkably close to the Kumar's second scenario and projection of Rosegrant with the help of IMPACT model.

Cereal Gap:

There are two types of food gaps. "The most divesting is the gap between actual food consumption as the quantity and quality of food required to sustain a healthy and productive life. The second type of food gap is the difference at the national level between food production and food demand as reflected in food imports. Growing imports are not a problem if they are the result of strong economic growth generating the necessary foreign exchange to pay for the food imports. However, if rapidly growing food imports are primarily a result of rapid income growth, they often act as a warning signal to national policy makers concerned with heavy reliance on world markets, and can induce the pressures for trade restrictions. More serious food security problems arise when the high food imports are the result of slow agricultural and economic development that fail to keep pace with basic food demand growth driven by population growth. Under these conditions, it may be impossible to finance the required imports on a continuing basis, causing a future deterioration in the ability to bridge the gap between food consumption and food required for basic Livelihood" (Rosegrant and Ringler, 1999). The nature of cereals gap in India is that of both types on the one hand there are 286 million malnourished and food insecure and on the other hand the rapid economic growth and fall in production growth rate as a result of environmental, financial, and social problem suggest that India shall imports large amount of cereals and other food items to feed its growing population.

By combining the demand and supply projection, we can assess the likely cereal gap for India in 2020, these gaps are reported in table 15for some of the important demand and supply scenarios

Table 12: Projected Cereals Gap in India in 2020 Under Different Scenarios of Demand and Supply.

		Demand (Food Plus Feed)		
		Bahalla's Projection With per capita income growth of:		
		2%	3.7%	6%
Supply Scenario	Total supply	257.3	296.2	374.7
1962/65-93 trend extrapolated	321.1	63.8	24.9	-53.6
1989/90-99 trend extrapolated	246.07	-11.2	-50.13	-128.63
IMPACT projections	237.0	-20.3	-59.2	-137.7
Kumar's Projections	249.66	-7.64	-46.54	-125.04
Bhalla's scenario 3	265.9	8.6	-30.3	-108.8
Bhalla's scenario 4	218.16	-39.14	-78.04	-156.54
Bhalla's scenario 5	360.4	103.1	64.2	-14.3
Bhalla's scenario 6	258.4	1.1	-37.8	-116.3
Bhalla's scenario 7	232.2	-25.1	-64	-142.5
Bhalla's scenario 8	259.9	2.6	-36.3	-114.8

Source: Bhalla et al, 1999. Kumar 1998, Rosegrant et al 1995.
Note: 1989/90-99 trends extrapolated by author.

According to first scenario (growth rate of 1963/95-93) India can remain food self sufficient only if the growth rate of 1962/65 to 93 continue over the next two decades and whole economy grow at the rate of 2% or 3.7%, even under this scenario if Indian economy continue to grow at the rate of 6% or above India will have to import 53 million tons of cereals by the year 2020. But Bhalla himself referred to the above scenario of supply as unrealistic one, because getting the growth rate of cereals production of 1963/65-93 back needs increase in public investment in research and infrastructure which as mentioned earlier in 1990s decelerated. On the basis of second scenario (growth rate of production of 1989/90-98/99), IMPACT projection, and Kumar's projection in all three demand scenario India shall import cereals the only difference is that of amount of import which needed to meet demand under different scenarios. Under the most of the other supply and demand scenarios (Bhalla's Scenario 3 to 8) India has to import cereals to meet its future requirement. The only scenario which provide an easier situation in cereal market for India is the fifth scenario, fertilizer use will rise to 334 kilogram per hectares and 50 percent of cultivated area is under irrigation which does not seem an easy target to achieve.

These results emphasize the need for strengthening efforts to increase production by maintaining or increasing productivity through public investment in irrigation, infrastructure development, research and efficient use of plant nutrients. However, as mentioned earlier the momentum of green revolution has generally waned. Considering the large projected demand for food in India, the decline in agricultural productivity is a matter of serious concern, but with right policies and investments the government is able to reduce the gap between demand and supply to manageable proportions.

A New Revolution in Agriculture:

Now after three and half decades after adoption of Green Revolution strategy, the prophets of doom have again started giving warnings regarding future food scarcity. There is no doubt that India has successfully increased its food supply as a result of adopting green revolution strategy in the mid sixties, but with international standards the productivity of Indian agriculture is still low, and with low productivity India wont be able to feed its population from domestic resources in the decades to come. But, there is considerable scope for additional agricultural growth. This would require additional policy reforms and market liberalization to bring price ratios more in line with world prices, and additional public investment in agriculture and rural areas (Bhalla, et al, 1999). Completion of reform process with full liberalization of domestic markets, foreign trade, and agro-industry would improve the terms of trade for many farmers and encourage greater cereal and livestock production (Gulati and Sharma, 1997).

Indian agriculture faces daunting challenges, however. Despite, national food surpluses, widespread hunger and poverty remain because the growths of agriculture and national economy have not adequately benefited the poor (Rosegrant et al, 1997). Today's grain policy may assist in short term food security, but they distort resource efficiency and impede long term food security, to improve the efficiency of resources use, including electricity, irrigation, fertilizer the government must raise prices. Low input prices encourage overuse especially in case of water and fertilizer and contribute to low efficiency and environmental degradation and food scarcity in future.

India is undertaking policy reforms to liberalize the economy that should improve the terms of trade for agriculture and encourage greater private investment. Historically the Indian trade policy discriminated against agriculture through protection of industrial sector. Policy reforms initiated in 1991, together with a process to open Indian agriculture to the world market, should change the relative incentive structure of the economy, allowing the agriculture to attract more private sector resources in the future.

However, policy reform alone will not be enough to increase agricultural growth and make it more equitable. The policy reforms must be accompanied by appropriate and efficient investments in public goods such as rural infrastructure, irrigation, agricultural research and extension, and education and health of rural people because public investment in these areas and specially in human development is still fundamental for achieving food security in India, but on the shadow of an ever tighter public budget these investment needs to be targeted in ways that are more beneficial to the poor than in the past, and supported by policy and institutional reforms that improve incentives for sustainable management of natural resources. In this context, it is disheartening to see that public investment in agriculture and rural areas is falling in India, a decline that is not being compensated for on any meaningful scale by private sector investment. It will not be easy to reverse this decline, but much more attention will need to be focused on doing more with less. India has proven that agricultural growth can be successfully achieved with the right public investment; even when economy-wide policies were unfavorable toward agriculture. Thus, India's promise of the future lies in combining policy reform with the right levels and kinds of public investments. The balance between input subsidies and long-term investments will be a crucial policy question as India proceeds with economic reform. Strong political forces still support subsidies for irrigation, electricity, and fertilizer, which could significantly slow the economic reform process and continue to divert funds from long term agricultural investments with grater impact on agricultural productivity.

Meeting the challenges of increasing food production now and in near future demand innovations that can lead to sustainable Green Revolution, which is now an ecological, social, and economical necessity in India. This involves new agricultural technologies and management systems providing increased productivity per unit of land, water, labor, energy, and investment without compromising on environment. To achieve the necessary yield growth without harming the environment is an enormous challenge. This challenge will have to be met largely through agricultural research, the annual rate of return to investment in agricultural research average 50-80 percent. Thus well-directed agricultural research and development programs remain a wise investment of public funds (Alston et al, 1995). This has to be done under the shadow of ever-tighter public research budgets. In conjunction with budgetary pressures, the emphasis of spending has to be shifted from research on farm inputs and output toward new concern such as environment and genetic diversity. Moreover, to reverse the effect of decline in public sector investment in agriculture and natural resources research, there is need to encourage participatory process involving farmers and civil society.

Future gain will essentially be realized through the generation and adoption of new appropriate technologies. New technologies such as information technology and biotechnology can provide the basic tools which are necessary to close food gap in India in 21st century in a sustainable manner, now the question is not availability of technology, the core issue is generating the mechanism for transferring it to small users in an effective manner. If the slogans such as achieving food and nutritional security and transformation of rural life, or achievement of growth with justice are to be translated in to reality, then the new technology must be such that the small poor and illiterate farmers can adopt it. There is a communication network, which makes available the latest finding of science almost immediately to research workers in any corner of the world; but what is urgently needed is such a communication network at the service of the poor farmer in India. It is not only the knowledge that is needed, but also an approach that will be able to supply the right knowledge and tools to right people and at the right time and place. Political independence depends on rapid economic growth and this in turn depends to performance in agriculture. The future of agriculture in its turn depends on the success with which the educated can help the small and illiterate farmers to take the many small steps which alone can lead to great agriculture, science can only show the way; it is for educated and privileged class to provide the will.

Agricultural growth has a continuing and crucial role to play in alleviating poverty and food insecurity in India, however, much more needs to be done than in the past to ensure that this growth is not environmentally destructive. India now is in the position to lunch an Evergreen Revolution, which can help to increase production, and income per unit of input used. It is possible by shifting research and development strategy from product and commodity approach to system approach. The green revolution was stimulated by the introduction of high yielding varieties seeds of wheat, rice and maize, an Evergreen Revolution can be triggered by introduction of a farming system which can help to produce more from less land, water and labor without compromising on either food security position or environment.

Chapter 6

Review of Policies and Programs for Improving Household Food Security

REVIEW OF POLICIES AND PROGRAMS FOR IMPROVING FOOD SECURITY

Types of Policies and Programs and Experience with their Food Security Effects:

To achieve food security at national level, a country must be able to produce or import the food it needs, and be able to store it, distribute it and ensure equitable access to it. At household level, households must have the means to produce or purchase the food that they need and they must have the time and knowledge to ensure that the nutritional needs of all family members are met.

Problem of food insecurity at the household level is the problem, which is mainly due to failure of command over certain amount of food, which is required for an active and healthy life (entitlement failure). "It is often argued that the real problem lies in shortage of purchasing power, rather than anything else" (Dreze and Sen, 1989). To improve Food Security "a wide range of alternative polices can be pursued; there is not just one general, optimal set of policies for improving food security. Characteristics of the food security problem and institutional capabilities need to be considered when making policy choices, as much economic and fiscal cost of desired actions (Von Braun et al. 1992). It is possible in principle to distinguish two contrasting approaches to the removal of Food insecurity. "One approach is to promote economic growth and take the best possible advantage of the potentialities released by greater general affluence, including not only an expansion of private incomes but also an improved basis for public support. This may be called the strategy of *growth-mediated security*. Another alternative is to resort directly to wide ranging public support in domains such as employment provision, income redistribution, health care, education, and social assistance in order to remove destitution without waiting for a transformation in the level of general affluence. Here success may have to be based on a discriminating use of national resources, the efficiency of public services, a redistributive bias in their delivery. This may be called the strategy of *support-led security*" (Dreze and Sen, 1989). Obviously, the two approaches are connected, especially in the long run (Von Braun 1992).

Production oriented programs that aim to increase food production on production of crops for sale or both can have favorable effects on food security if they increase or stabilize the real incomes of the people facing food insecurity. Growth in food supplied can have a dual effects on food security by reducing food prices, which benefits food purchasing households in rural and urban areas and depending on the nature of growth by promoting employment. As incomes of poor households increase, their absolute expenditure on food consumption also increases, although the relative share tends to decrease (Von Braun et al. 1992). Agricultural production growth often entails a substantial expansion in demand for hired labor, and to the extent that wage labor households rank among the food-insecure population, this employment generation effect is of particular benefit to them. There are other, somewhat more indirect, effects of agricultural production growth on food security that are noteworthy. First, off form non-agricultural activities often contribute a significant proportion of total household income. Much of this non-agricultural employment and income is derived from increased demand for local goods and services, which in turn is partly the consequence of multiplier effect of agricultural growth due to commercialization and technological change (Mellor 1986, Hazell and Roell 1983). Second, poor household build up their asset base out of incremental income. Agricultural growth permits an expanded asset base, which makes households less vulnerable to short term disruption in their income streams (Von Braun et al. 1992).

Thus it is clear that "while land owning households benefit most from the direct income effects of agricultural growth, landless and small food-deficit farmers benefit most from indirect effects or off-form employment generation (Hossein 1988). These indirect employment effects that help the poorest households are further facilitated by infrastructural development (Ahmed and Hossein 1990).

Besides polices and programs oriented toward agricultural production, other programs for generation and diversification of employment and income can reduce risks for food-insecure households. These programs differ from programs oriented toward food production. This type of program is used to stimulate or stabilize demand for food but may not directly expand the food supply simultaneously. They include labor-intensive public work for food security, and credit to the poor for consumption stabilization and self-employment.

Labor-Intensive Public Works programs can address, simultaneously, three central problems facing many low-income countries to day - food insecurity, growing unemployment and poor infrastructure - (see Dreze and Sen 1989; Von Braun, Teklu, and Webb 1991, IFPRI/BIDS 1989). They are in general public programs that provide employment and generate public goods such as physical and social infrastructure. Labor-intensive public works go a long way toward direct and sustainable poverty alleviation and strengthening of self-help capacities.

The household food security effects of labor-intensive public works programs are a function of program design. For instance, a short-term project may result in expenditure patterns by the poor that treat project income as windfall profits. An example from Guatemala hints at that behavior. A similar explanation may be attributed to the small food consumption benefits observed during the short mark season of Bangladesh food for work program (Kumar and Chaudhry 1985, Osmani and Chaudhry 1983). In contrast long-term benefits from improved rural infrastructure produce more secure income flow and substantial consumption improvements for the lowest-income households, for example, in rural Bangladesh villages with better infrastructure development 12 percent of households were food insecure (that is, consuming less than 80 percent of calorie requirements) compared with 20 percent in villages with poor infrastructure (Kumar 1988). This difference is explained by higher income (18 percent more employment was available for the landless) and lower prices of marketed items in villages with better-developed infrastructure. Thus, the creation of productive and sustainable assets needs to be emphasized in policy. It is important to note, however, that income effects derived from public works programs for the poor also have favorable private savings and investments effects that improve household food security, as observed from experiences in Bangladesh and Guatemala (Kumar 1988; Bell, Hay, and Martinez 1989).

Public works programs can be viable instrument for famine prevention, as demonstrated by the Employment Guarantee Scheme (EGS) from Maharashtra, India. The scheme provides an unlimited guarantee of employment to all adults in rural Maharashtra who are willing and able to work at the given wage. A program such as the EGS that includes an employment guarantee as well as favorable employment stabilization and insurance effects stands out as a model.

The target group of labor intensive public works programs, the food-insecure poor, are successfully reached through a variety of mechanisms and design features that include wage rate policy, regional targeting, and specific selection of households (for example, displaced households) and of household members (for example women). Properly designed public works programs have a unique feature in favor of poverty alleviation with low administrative costs and effects: self-targeting. At properly defined wage rates, the working poor identify themselves by appearing at public works schemes. However, the self-targeting feature of public works programs operates effectively only with an appropriately low wages rate policy and a flexible absorption of applicants without rationing workplaces (Ravallioin, Datt, and Chaudhry 1990).

The issue of payment entirely in cash or partly in kind is related to the wider problem of wage-rate determination and to the question of risk of food-market failure. Regularity of payment may be another critical requirement for workers. Where market disruptions occurred, workers had a strong preference for in-kind payment (Webb, Von Braun, and Yohannes 1991). When increased demand for food is induced through a large public works scheme, food must be forthcoming locally or inflation may result, which will also affect nonparticipating households. (Von Braun, 1992).

Credit to the poor for consumption stabilization and for promotion of self-employment through private investment is an important mechanism for improving food security in the growing and diversifying rural economies of many low-income countries. Many interesting innovations occurred in programs of this type in the 1980s. These programs are most likely to succeed in areas where agricultural growth is proceeding well and where there is good infrastructure coverage and market activity; non-farm activities can easily be further stimulated. Programs that have been found to be most successful in generating self-employment for the poor and stabilizing their consumption, one those that combine small-scale credit with groups motivation, technical evidence, and assistance in institution building, such as Bangladesh Grameen Bank (Von Braun et al., 1992).

Food income transfers (food Subsidies) are a widely used means of alleviating food insecurity. "Policies intended to encourage growth in food production were expected to involve incentives to producers such as high prices for food and improved technology to lower production costs. Such policies would clearly benefit many in the agricultural sector. The landless rural poor and urban poor, however, would not be able to take direct advantage of the new technologies because they lacked kind, and they would be forced to buy food at higher prices. Interventions in the market might well be needed to protect these groups at least in the short run" (Farrar, 2000). In fact food subsidies aim is to increase effective demand for food. The food subsides, especially during the 1980s, come under attack for their potential adverse effects on markets and for their high fiscal costs. Subsidies are also referred to as symptom of the failure of development policy. Nevertheless, they might be acceptable, even necessary, so long as they did not get in the way of long-term development (Mellor and Ahmed, 1988).

Subsidies may be implicit, that is paid indirectly, usually by producers who receive prices lower than a free market would provide; or may be explicit, that is paid from the budget; or they may be a combination of the two. Explicit subsidies are of two major types: distribution of foods at prices below the price that would be fixed by the market, or distribution of food stamp that are a form of redistribution of income without direct price effect. Price reductions may be for the total quantity of one or more commodities, or for specified amounts, usually called rations. Price reduction caused by subsidies may be large, but may vary depending on world prices and other factors. Provided that they have access to the subsidized price, reductions in the price of food are relatively more important to the poor, because of the weight of food in their expenditure pattern (Farrar, 2000).

Consumer food price subsides are very widespread and have been introduced in nearly every low and middle-income country in the past few decades. Household food security is a common goal among other goals of subsidy programs (Von Braun et al, 1992). Andersen 1988 reviewed the origins and effects of programs in many developing countries, such as ration shop schemes in India, Pakistan and Bangladesh and food subsidies in Egypt, shows that they were established to assure consumers of access to specified quantity of food staples at fixed (subsidized) prices. Many of these programs were introduced or expanded during wartime or specific food crisis situations. "The principal purpose of the schemes when initiated was clearly one of reducing uncertainty at the household level concerning the ability to acquire a certain minimum amount of food staple" (Andersen 1988). Overtime, the initial objectives have been frequently diluted, as powerful interest groups, primarily the urban middle classes, have bought into subsidy programs for their own benefit. An indicator of this dilution is provided by changes in commodity coverage; programs initially included essential staples only, but coverage has been expanded to include sugar in India and chicken in Egypt, for instance (Von Braun, 1992).

Two of the most common types of food price subsidies are the generalized price subsidy, which sets a lower market price for a commodity that benefits all consumers, and the limited-access subsidy, which rations a commodity to some or all members of a community at a price lower than that prevailing in the open market. Generalized price subsides are much more costly in terms of fiscal and economic costs than limited access subsides and are also more regressive in the distribution of economic benefits. Targeting of subsidies "lies at the heart of attempts to reach the poorest of the poor. Food security often defined as adequate access to food at all times, throughout the year and from year to year. Suppose this general definition is specified more narrowly. Specifically, a person is food-secure if the number of calories available for her to eat exceeds her requirements. If calories availability is less than nutritional requirements, she is described as food insecure. Accordingly, it is tempting to assume that the objective of targeting is to produce the greatest decrease in the percentage of individuals who are food insecure.

But targeting is not nearly as straightforward as is often suggested. Indeed, it is possible that a targeted intervention will be more costly, and less effective, than are made available to all households or that is randomly allocated" (Hoddinott, 1999). The case for targeting is complicated by several factors: First, targeting is not costless, it impasses administrative costs that reduce the amount of money available for the actual intervention. These costs will vary with the degree or fineness of targeting. There are certain fixed costs associated with targeting. Targeting which are on the bases of geography, may be relatively costless. As targeting moves below a certain geographical level to villages to households, and to individuals, it becomes increasingly costly. Seconds when subsidies are targeted; there is possibility that some food-insecure households will be missed and some food-secure households will benefit. This can describe as error of inclusion and exclusion. An error of inclusion is one in which an intervention reaches individual who were not intended to be beneficiaries. An error of exclusion occurs when intended beneficiaries are not able or permitted to participate in the intervention.

Policies and Programs for Achieving Household Food Security in India:

The policies and programs for achieving household food security are based on the identification of the characteristics of the food insecure households and individuals. As indicated earlier. There is a close link between poverty and household food security, which highlights the relevance of various macro economic policies and poverty alleviation programs. Since the majority of poor live in the rural areas and since most of them are small farmers or landless agricultural laborers, the policies pursued in relation to agricultural development have a high significance. Apart from the macro economic policies in general, and in particular the agricultural policies and poverty alleviation programs, a number of direct interventions such as public distribution of food grains and feeding programs are relevant in the achieving household food security (George, 1999).

Agricultural Policies:

Agricultural development polices pursued by the Central and State Governments have wide-ranging influence on food security through availability of food (which determines physical access), farm income and employment opportunities. The specific policies followed in this category include support for technology, irrigation, farm inputs, agricultural prices, agricultural credit, institutional framework including tenancy and land reforms, agricultural trade, and infrastructure including agro-processing industries, transport facilities and agricultural marketing. Most of these policies were initiated to achieve the national goals such as self-sufficiency in food production, equity and resource use efficiency. Programs for increased food production, both for home consumption and for commercial purposes, influence household food security through increase physical access and increase purchasing power through sale of agricultural products and promotion of employment opportunities (Binswanger and Braun, 1991). The beneficial impact of technological changes, as reflected in the Green Revolution, were identified to include increased farm output, employment and wages (Bhalla, 1983). The policies for maintaining food prices within the reach of the poor, on the one hand, and safeguarding the interest of farmers through remunerative prices also had their impact on food security. While there has been a realization that the benefits through major agricultural programs can be fully utilized by the rural poor only when the poor gets control over resources, especially land, in the absence of adequate measures on land reforms (redistribution, tenancy reform and consolidation of holdings) the poor have not been able to derive the full benefits of these measures in many areas, with the possible exception of Kerala and West Bengal. There is a feeling that the problems of the rural poor cannot be solved by simply augmenting agricultural production. Vyas 1986, has pointed out that the diversification of the rural economy is the major challenge. He asserts that "without conscious decisions to encourage non-farm activities, the large bulk of the rural people cannot be provided with opportunities for gainful employment and income and access to food".

Anti-Poverty Programs:

The various anti-poverty programs followed in India can be broadly classified as Income and Employment Generation Programs and Targeted Distribution Programs. While the activities initiated under the macro-economic policies and agricultural development policies might contribute towards increased food production (physical access) and increased purchasing power (economic access), anti poverty programs might contribute towards increased economic access and stabilize the demand for food for the food insecure population.

Income and Employment Generation Programs:

The income and employment generation programs pursued in India belong to two broad categories of self-employment and wage employment programs. The major self-employment programs include the Integrated Rural Development Program (IRDP), Training Rural Youth for Self-Employment (TRYSEM) and Development of Women and Children in Rural Areas (DWCRA). The Jawahar Rozgar Yojana (JRY) is the main wage-employment program pursued at the all-India level, and some state governments have employment guarantee schemes along the lines of the Employment Guarantee Scheme in Maharashtra.

Integrated Rural Development Program:

The basic objective of the IRDP which was introduced during the sixth five year plan (1980-85) period as a follow up of the earlier Small Farmer Development Agency (SFDA) and the Marginal Farmer and Agricultural Labor (MFAL) development programmer has been "to enable identified rural poor families to augment their incomes and cross the poverty line through acquisition of credit based productive assets" (Government of India, 1999).

Assistance provided under this program includes subsidy by the government and a low-interest term credit by the financial institutions for income generating activities. The number of beneficiary families under the IRDP from 1980-81 to November 1998 is estimated to be 53.5 million (an average of 3 million families each year). The level of family investment increased from Rs. 1.642 during 1980-81 to Rs. 17,441 during 1998-99.

Many evaluation studies of the IRDP have been critical about the efficiency of achieving poverty alleviation through asset creating self-employment programs, choice of activities for providing subsidy (a large share for purchasing cattle) and the choice of beneficiaries (Rath, 1985; Dreze, 1990; Tendulkar et al., 1993). However, some others would argue that the programs under IRDP may have achieved very little and may have been misconceived, but that does not prove that the strategy of generating assets for the poor and upgrading their skills is wrong (Dantwala, 1985).

Training of Rural Youth for Self-Employment (TRYSEM):

The objective of the program is to train rural youth in the age group of 18-35 from the families below poverty line to develop some skills required for them to take up self-employment programs in the broad fields or agriculture and allied activities, industries and service sectors. There is also a provision for assistance to start own enterprises with loan and subsidy under IRDP to the rural youths trained under TRYSEM.

Development of Women and Children in Rural Areas (DWCRA):

The DWCRA is a sub-component of the IRDP and its main objective is to provide opportunities of self-employment to women members of households below poverty line. The strategy is to focus on groups consisting of 10-15 women and the activities included specific items in the areas of social welfare, health, nutrition, employment and education. Here again, the contribution of these programs to income generation is not properly estimated.

Jawahar Rozgar Yojana (JRY):

JRY which was created by merging the earlier programs of National Rural Employment Program (NREP) and Rural Landless Employment Guarantee Program (RLEGP), is major wage-employment program. The main objective of JRY is to create additional gainful employment for the unemployed und under employed rural population living below the poverty line. It also envisages strengthening of rural economic infrastructure and creation of durable community assets to improve the quality of rural life. An evaluation study of the JRY conducted in 1992 has indicated that more than half the, beneficiaries were above the poverty line (Neelakantan, 1994).

In addition to these major employment and income programs, there are a number of other programs such as the Employment Assurance Scheme (EAS), the Swarana Jayanti Shabari Rozgar Yojana (SJSRY) and the Prime Ministers Rozgar Yojana (PMRY).

Target Oriented Programs:

Public Distribution System and nutrition programs are the two important items among the target-oriented programs.

Public Distribution System (PDS):

The PDS, which has its origin during the Second World War period has been an important source for enhancing the food security of the poor (George. 1983). The Central Government has the responsibility for the supply of rice. Wheat, sugar imported edible oils and kerosene to the state governments and these items are distributed through a network of about 4.5 lakh retail outlets known as the fair price shops. While the coverage was mainly confined to major urban areas in many states, some deficit states such as Kerala has an elaborate network of fair price shops for distribution of food grains and other essential items and cereals purchased from these shops accounted for a major share of the consumption of the low income groups (George, 1979, 1996). A number of studies on PDS have brought out the problems of PDS such as inadequate coverage (Parikh, 1994), lack of price advantage (Radhakrishna and Indrakant, 1987), leakages (Ahluwalia, 1993), urban bias and inefficiencies of handling agencies including Food Corporation of India.

Nutritional Programs:

The nutritional programs include supplementary feeding vitamin supplement and Integrated Child Development Services (ICDS). Supplementary feeding programs aim at controlling protein energy malnutrition among pre-school children, and pregnant and nursing women, and also to improve school enrolment and nutritional status of elementary school children. Programs for supplementing vitamins include distribution of vitamin A among pre-school children, folifer tablets (iron and folic acid) among pre-school children and nursing women, and iodized salt. The ICDS, whose target group included children below the age of 6 and expectant and nursing mothers offers a package of services including health check-ups, immunization, supplementary feeding, nutrition and health, pre-school education for children and nutrition education for mothers. The ICDS which was started with 33 experimental projects has expanded to about 3400 projects covering about 18 million children and 3.5 million mothers. In spite of the limitations of ICDS, it is worth noting that most of the ICDS beneficiaries belong to deprived socio-economic groups and they have experienced a decline in the incidence of morbidily and also an improvement in the enrolment in primary schools and decrease in school dropout rates.

PAST, PRESENT AND FUTURE FOOD POLICY

Evolution of Food Policy in India:

The need for evolving a comprehensive food policy in India was felt for the first time after the Bengal Famine of 1943 and following the recommendations of the Food Policy Committee, 1943 (GOI, 1944), the Government became an active partner in the management of food economy of the country. This Committee believed that public opinion would not tolerate a hand off attitude adopted by the Government in the matter of food. This report was a watershed in the evolution of food policy in India the theory of controls had come in. Even after independence the central Government remained active in the management of food economy. For some years it appeared that the policy was moving towards complete free trade but soon after the position changed and it seemed as if it was moving in the direction of full control. Until the middle of the sixties the basic concern of food policy had, to a great extent, remained protection of consumers against any sharp increase in the prices of food grains. It was recognized only at the time of the Third Five- Year Plan that a positive price policy would induce farmers to increase investment in agriculture which in turn would help in accelerating the growth of' domestic production of food grains. Since then assuring farmers a fair price for their produce has remained an important component of India's food policy. For safeguarding the interest of consumers, particularly of the more vulnerable sections of the community, the Public Distribution System through a network of Fair Price Shops has been another component of the policy. The third component of the food policy has been that of holding adequate stocks of food grains as a measure of food security in the country not only to impart inter- seasonal stability to food prices but also to meet any emergent situation that may arise due to crop failures, floods, etc. As any study of food security in India is incomplete without study of food management system in this chapter a brief discussion of the present system of managing India's food economy is presented.

Macroeconomic Policy and Food Policy:

In this context it needs to be mentioned that both food policy as well as the food system, to a great extent, are influenced by the macroeconomic policy. In the long run macroeconomic forces are too pervasive and too powerful for the micro sector strategies to overcome. The three main areas of the macro policy that have a significant bearing on food policy are budget, fiscal and monetary policy, and macro prices (foreign exchange rates, interest rates and wage rates). Figure 1 summarizes the impact of macro policies on food policy and on the food system itself. These apart, there are other policy measures, such as, regulation of international trade, regulation of domestic markets both through monetary policy and regulatory measures, regulatory and fiscal measures for influencing the final demand, and regulation of forward markets that influence the level of food prices in the country and thus at times can have a profound impact on the food policy. However, we shall confine the discussion only to those measures and policies that have been initiated in the context of food policy though we recognize that the management of food policy would have been influenced by the macro, policies to a significant extent in some years.

India's national leaders had envisaged long before independence to bring about the socio-economic transformation of the country through planned development (Misra, 1988). This was reflected in the adoption of the constitution in 1950 where planning was assigned a definite role in bringing about economic development. The basic objectives of planning in India have been growth, social justice, self-reliance, alleviation of poverty, modernization and improvement in productivity. These objectives were sought to be achieved within the framework of a democratic system, which conferred upon the citizens, the right to property, the right to choose their occupation and freedom to conduct business in a relatively large sphere of activities. Recognizing that the natural economic processes based on the functioning of the market and price system tended to exclude the poor and those without productive assets from the mainstream of development, the state had to take special care of these sections (Hasim and Singh, 1986). The state had to provide a purposive guidance to development. One of the strong instruments for influencing the course of development in this context was the public sector. The institution of market was, however, retained and was expected to play a significant role. Developments in food Policy as well as in its management front have to be viewed in the light of this background.

Concerned Ministries and Institutions:

The main constituents of Government's food management policy are procurement, storage, movement, public distribution and maintenance of the buffer stocks of food grains. The other related aspects of this policy are production, procurement and issue prices of food grains, quality control, imports and exports, behaviour of market prices etc. The formulation and implementation of national policies on procurement, imports, movement, distribution and stocking of food grains are the functions of the Union Department of Food. In addition, the Department of Food is also responsible for making provision of storage facilities for the maintenance of food grains reserves, promotion of scientific storage and regulation and development of rice milling and wheat milling industries in the country. The Department of Civil Supplies is responsible for monitoring prices and .for the availability of essential commodities. This Department is also responsible for the public distribution system, consumer protection and consumer cooperatives. Internal trade, inter-state trade, control of future trading are also the responsibility of the Department of Civil Supplies. The Department of Agriculture and Cooperation is responsible for the formulation and implementation of national policies and programs aimed at achieving rapid agricultural growth including the growth of food grains production through the optimum utilization of the country's land, water, soil and other resources. The collection and maintenance of a wide range of statistical and economic data relating to the agricultural sector including food grains is also the responsibility of this Department. Further, it also assumes the responsibility of ensuring remunerative returns to the farmers for their agricultural produce. In addition, the Department assists and advises the States in undertaking scarcity relief measures and in the management of natural calamities, e.g., floods, droughts and cyclones. Thus, in the management of India's food economy, apart from the Planning Commission which plays a crucial role in the allocation of resources to different sectors/States and the Ministry of Finance which decides and monitors fiscal and monetary policies which have a significant bearing on the supply and demand of food grains in the country and controls the allocation of foreign exchange for imports, the three Central Departments of Food, Civil Supplies and Agriculture play a predominant role.

It is evident from the above that it is the Union Department of Food which is primarily responsible for the crucial components of managing India's food policy. The procurement of food grains whether from the domestic market or from the world market is the first major element for managing the food economy. This decision, however, crucially depends on the expected size of domestic crop, the expected level of domestic demand, and the estimated requirement of food grains for distribution through the Public Distribution System. For arriving at a balance-sheet for food grains the first requirement is information relating to the size of the crop. This responsibility rests with the Ministry of Agriculture and it is the Directorate of Economics and Statistics in the Ministry of Agriculture (DESAg) which provides estimates regarding the size of food grains output in the country.

Commission on Agricultural Costs and Prices (CACP):

The procurement of food grains in the domestic market by the Government has to be done at a price. In order to increase food production, one of the objective of the food policy has been that of assuring a fair price to the farmers for their produce. For advising the government on the pricing policy for agricultural commodities including food grains, the agricultural prices commission (now commission for Agricultural Costs and Prices) was set up in 1965 (Tyagi, 1990). The terms of reference of the agricultural prices commission required that while recommending the price policy and relative prices structure the commission may keep in view the following: (i) the need to provide an incentive to the producer for adjusting improved technology and for developing a production pattern broadly in the light of rational requirements, (ii) the need to ensure rational utilisation of land, water and other production resources; (iii) the likely effect of the price policy on the rest of the economy, particularly on the cost of living, level of wages, industrial cost structure, etc. (GoI, 1986).

When working out support/procurement prices, the CACP uses several criteria. These are cost of production, changes in input prices, input-output price parity, trends in market prices, demand and supply situation, inter-crop prices parity, the likely effect of changes in prices on the cost of manufacturing of industrial goods and the cost of living, the international market price situation, and the parity between prices paid and prices received by the farmers. The prices fixed by the government assure the producer a certain minimum price, even in the event of output outstripping demands, thus reducing the producers risk.

In case of food grains, the commission recognizing that two sets of price should be fixed by the government. They include the minimum support price and procurement prices. The minimum support price fixed by the government are in the nature of a long term guarantee to enable the producer to pursue his efforts with the assurance that the price of his produce would not be allowed to fall below the level fixed by the government even in the event of a glut in the market arising out of excess production or the lack of purchasing power in the market. As against this, the procurement price is a price at which the government procures grains. Normally, the procurement price is lower than the open market price but higher than the minimum support price. The procurement price has to be determine in addition to the factors governing the determination of the minimum support price level by the required size of procurement that may be considered necessary for managing efficiently the food economy and the likely behavior of market prices in the post-harvest period. Until the early seventies, two sets of prices were fixed for food grains. However, later by virtue of the assurance given by the government that the entire quantity of cereals offered to procurement agencies would be lifted by them at procurement prices, the latter in effect became the support prices. Thus the procurement of cereals during a year of bumper harvest can be considered to be the outcome of the price support operations rather than that of the procurement operation (Tyagi, 1990).

In this context, it may be mentioned that so long as the situation of food grains in the country remained tight and for meeting the requirements of the Public Distribution System, emphasis had to be placed on enlarging the size of procurement, the Commission for Agricultural Costs and Prices used to recommend the target of procurement for various cereals for different states. Till 1978 restriction on the movement of food grains were also imposed for maximizing the size of procurement. However, with the supply situation turning comfortable, the Commission for Agricultural Costs and Prices gave up making recommendations on the targets procurement after 1978.

Procurement Agencies:

The Food Corporation of India (FCI) was established on January 1, 1965 as the sole agency of the Central Government to purchase, store, transport and distribute food grains.

Until the late seventies the FCI used to handle all cereals including coarse cereals but since 1980 the FCI has confined its operation to only wheat and rice. Coarse cereals are now handled by the National Agriculture Cooperative Marketing Federation (NAFED). The FCI has its own subordinate offices in the states and in the districts. It has its own godowns and silos. It has also set up processing plants.

Price support purchases are organized in more than 8,000 centers for wheat and 4,000 centers for paddy every year in the immediate post harvest season. Food grains are procured according to the government prescribed quality standards. Each year, the Food Corporation of India purchases roughly 15-20% of India's wheat production and 12-15% of its rice production. This helps to meet the commitments of the Public Distribution System and for building buffer stock. Food Corporation of India operates through a country-wide network with its Corporate office in New Delhi, 5 Zonal offices, 22 Regional offices practically in all the State capitals, 1 Port operation office, 173 District offices and over 2178 depots (as on 31.03.2002). It has a manpower of 59089 employees (excluding handling workers) as on 31.03.2002. The general superintendence, direction and management of the affairs and business of the corporation is vested in a board of directors which exercise all such powers as may be exercised or done by the corporation under this Act. The board of directors, in discharging its functions, act on business principles having regard to the interest of the producer and consumer and shall be guided by such instructions on questions of policy as may be given to it by the Central Government.

Food Distribution System in India:

In India, the objective of ensuring food security for the poor is dealt through various welfare enhancing institutional measures/systems. These measures/systems are the Pubic Distribution System (PDS), Employment Guarantee Scheme, community managed PDS and grain bank, etc.

The Public Distribution System in India was evolved in the context of the scarcity situation created by the Second World War and the Bengal famine of 1943. It can be traced back to an adhoc measure devised during the Second World War to keep the cities supplied with grains. The system was designed to deal with the periodic scarcities in the urban market resulting from droughts and crops failures.

The advantage with the PDS is that it provided the government the opportunity to fix both sets of prices: the support prices and the prices at which grains could be sold through ration shops; it could decide how much to accumulate and distribute, as the occasion demanded, for price stabilization and so on.

It is the joint responsibility of the central Government; state Government and Union Territory Administration to ensure the smooth functioning of the Public Distribution System. While the responsibility of central Government is to procure, store and transport it from purchase points to central godowns, the responsibility of state Governments and Union Territory Administration is to lift these commodities from the central godowns and distribute them to consumers through the network of Fair Price Shops. The distribution of food grains is undertaken by the Government through Fair Price Shops to meet the needs of deficit areas and the poorer strata of the population from the internally procured and imported quantities often at the subsidized prices (Tyagi, 1990).

Buffer Stock:

In a country, where agriculture production is still largely monsoon-dependent and large scale year to year fluctuations persist, the options for providing a measure of food security are limited to large scale food imports or maintaining a buffer stock. Since India has chosen the path of self-reliance, the maintaining massive buffer stock becomes inevitable involving large cost to the exchequer (Ramachandra, 1994).

The objectives of a buffer stock are three fold:

1. To cater for the lean years when a minimum level of consumption must be provided.
2. To ensure a continuous supply of food grain through the PDS throughout the year; and
3. To give price support to the farmers in a bumper crop year.

Grain surplus countries have a buffer stock for the sake of the producers, i.e. to protect his income by exporting. In deficit countries, it is necessary to protect consumer's interest, at the same time not giving up the producer's interest in order to sustain the pace of production (Chopra, 1988). Buffer stocks are built up by absorbing the excess production of a good crop year, or by setting aside a specified quantity out of imports every year, to be released during years of bad crop or crop failure.

The importance of building up of a buffer stock of food grains to stabilize the food economy of country has been recognized ever since food difficulties arose in 1943. Various proposals were considered by the Government for the creation of central reserves of food grains. Several committees including the Food Grains Policy Committee of 1943 (GoI, 1944), the Famine Enquiry Commission of 1945 (GoI, 1945), the Food Grain Enquiry Commission of 1957 (GoI, 1957) and the Food Grains Policy Committee of 1966 (GoI, 1966) have recommended the creation of a buffer stock.

The Food Grains Policy Committee of 1943 recommended creation of central food grain reserve of not less than 5 lakh tons. By 1957, an emergency reserve stock of at least 2 million tons was mooted. The Food Grains Policy Committee of 1966 suggested building up a stock of 4 million tons with a view to achieving inter-seasonal stability in supplies together with the stabilization of price. A Technical Group constituted in the December 1975 to go into the question of volume of food grains to be handled by the public agencies and the reserve stock that would be required to tide over the inter-seasonal price fluctuations. It was also expected to examine the question of increasing the size of the buffer stock. The group, after carefully examining variations in food grain production and consumption during the period of 1960-61 to 1975-76 and also analyzing the gap between the requirement of the public distribution system and procurement in different years, recommended for the creation of a stock of nearly 12 million tons.

In April 1981, the central Government appointed another Technical Group to examine whether in the light of the experience of the past decade; the level of national buffer stock of 15 million tons would be adequate.

In the last decade it was recognized that the safe level of buffer stock of food grains (i.e. rice and wheat) is 24 million tons as of July 1st every year (Economic Survey, 2001-02). Pre-1999, stock level were not abnormal. But food grain stocks were about 34 million tons on July 1999, around 43 million tons on July 1st 2000, and approximately 62 million tons on July 1st 2001 (Table 1).

Table 1: Central Food Grain Stocks and Minimum Buffer Stock Norms

Beginning of the month	***Wheat***		***Rice***		***Total***	
	Min. Norm	**Actual Stock**	**Min. Norm**	**Actual Stock**	**Min. Norm**	**Actual Stock**
January – 1994	7.7	10.8	7.7	11.2	15.4	22.0
April	3.7	7.0	10.8	13.5	14.5	20.5
July	13.1	17.5	9.2	13.3	22.3	30.7
October	10.6	15.6	6.0	10.9	16.6	26.5
January 1995	7.7	12.9	7.7	17.4	15.4	30.3
April	3.7	8.7	10.8	18.1	14.5	26.3
July	8.1	19.2	9.2	16.4	22.3	35.6
October	10.6	16.9	6.0	13.0	16.6	29.9
January 1996	7.7	13.1	7.7	15.4	15.4	28.5
April	3.7	7.8	10.8	13.1	14.5	20.9
July	13.1	14.1	9.2	12.9	22.3	27.0
October	10.6	10.5	6.0	9.3	16.6	19.3
January 1997	7.7	7.1	7.7	12.9	15.4	20.0
April	3.7	3.2	10.8	13.2	14.5	16.4

July	13.1	11.4	9.2	11.0	22.5	22.4
October	10.6	8.3	6.0	7.0	16.6	15.3
January 1998	7.7	6.8	7.7	11.5	15.4	18.3
April	3.7	5.1	10.8	13.1	14.5	18.2
July	13.1	16.5	9.2	12.0	22.3	28.5
October	10.6	15.2	7.7	9.0	16.6	24.2
January 1999	8.4	12.7	8.4	11.7	16.8	24.4
April	4.0	9.7	11.8	12.2	15.8	21.9
July	14.3	22.5	10.0	10.6	24.3	33.1
October	11.6	20.3	6.5	7.7	18.1	28.0
January 2000	8.4	17.2	8.4	14.2	16.8	31.4
April	4.0	13.2	11.8	15.7	15.8	21.7
July	14.3	27.8	10.0	14.5	24.3	42.2
October	11.6	26.9	6.5	13.2	18.1	40.1
January 2001	8.4	25.0	8.4	20.7	16.8	45.7

Source: Economic Survey, 2001-2002.

In 1970s, procurement of food grains by the Food Corporation of India (FCI) averaged about 10 million tons annually. In the 1980s, it average around 18 million tons per year. Between 1990 and 1999, procurement averaged 23.6 million tons, it further increased to 35.5 million tons in 2000, and estimated to be 42.2 million tons in 2001.

Punjab, Andhara Pradesh and Haryana account for over 80 percent of rice procurement. Punjab, Haryana and Uttar Pradesh account for 90% of the wheat procurement. Procurement is Punjab's lifeline; here over half of the wheat and three-fourths of the rice output is purchased by the FCI.

The central Government pushes the procured food grains through Public Distribution System (PDS), which has a network of about 4.6 lakh ration shops.

On an average in the 1970s about 11 million tons, in the 1980s around 16 million tons and in 1990s, 17 million tons were pushed through the PDS (Table 2).

Table 2: Public Distribution and Procurement of Food Grains 1970-2001.

Year	*Distribution*	*Procurement*	*Year*	*Distribution*	*Procurement*	*Year*	*Distribution*	*Procurement*
1970	8.8	6.7	1980	15.0	11.2	1990	16.0	24.0
1971	7.8	8.9	1981	13.0	13.0	1991	20.8	19.6
1972	10.5	7.7	1982	14.8	15.4	1992	18.8	17.9
1973	11.4	8.4	1983	16.25	15.6	1993	16.4	28.1
1974	10.8	5.6	1984	13.3	18.7	1994	14.0	26.0
1975	11.3	9.6	1985	15.8	20.1	1995	15.3	22.6
1976	9.2	12.8	1986	17.3	19.7	1996	18.3	19.8
1977	11.7	9.9	1987	18.7	15.7	1997	17.8	23.6
1978	10.2	11.1	1988	18.6	14.1	1998	18.6	26.3
1979	11.7	13.8	1989	16.4	18.9	1999	17.7	30.8
Agg.	10.34	9.45	Agg.	15.96	16.24	Agg.	17.37	23.87

Source: Indian Economic Survey, 2000-2001.

On the other hand procurement on average during the 1970s and 1980s was 9.45 million tons and 16.24 million tons respectively. Thus, the balance between procurement and PDS supply was more or less maintained. But this balance did not continue during the 1990s. During the 1990s the public distribution push on average was 17.37 million tons while the average procurement was 23.87 million tons, as a result the government stock increased to the record level of 62 million tons in the year 2001.

The main cause of increase in procurement over, public distribution push is liberal increases in the minimum support price (Table 3).

Table 3: Minimum Support Price/Procurement Price of Wheat and Paddy (Rs./quintal)

Wheat			*Paddy*				
Crop year	**MSP**	**% Change**	**Common**	**% Change**	**Fine**	**Super Fine**	**Grade A**
1991-92	275	11.1	230	12.2	240	250	-
1992-93	330	20.0	270	17.4	280	290	-
1993-94	350	6.1	310	14.8	330	350	-
1994-95	360	2.9	340	9.7	360	380	-
1995-96	380	5.6	360	5.9	375	395	-
1996-97	475	25.0	380	5.6	395	415	-
1997-98	510	7.4	415	9.2	-	-	455
1998-99	550	7.8	440	6.0	-	-	470
1999-00	580	5.6	490	11.4	-	-	520
2000-01	610	5.2	510	4.1	-	-	540
2000-02	-	-	530	3.9	-	-	560

Source: Economic Survey 2001-02.
Note: Since 1997-98, MSP is fixed for only two varieties of paddy, common and grade A.

There are also sets of demand side factors, which are responsible for over flowing grain stocks in India. While there has been excessive procurement of rice and wheat, off take of food grain under the public distribution system has been low particularly in case of wheat (Table 4).

Table 4: Food Grain Allocation and off take Under Public Distribution System (million tons)

	Wheat		*Rice*	
Year	*Allocation*	*Off take*	*Allocation*	*Off take*
1991-92	10.56	8.83	11.36	10.17
1992-93	9.25	7.85	11.48	9.55
1993-94	9.56	5.91	12.41	8.87
1994-95	10.80	4.83	13.32	8.03
1995-96	11.31	5.29	14.62	9.46
1996-97	10.72	8.52	15.10	11.14
1997-98	10.11	7.08	12.83	9.90
1998-99	10.11	7.15	12.93	10.74
1999-00	10.37	5.76	13.84	11.31
2000-01	12.29	3.98	16.26	7.74
2000-02 (upto Dec.)	9.08	3.15	11.48	5.23

Source: Economic Survey, 2001-2002

In 1991-92, the off take of wheat was 86 percent of the quantity allocated for PDS while in case of rice off take was about 90 percent of the allocated quantity. However, in 2000-01, off take in case of wheat fell to 32 percent while for rice it fell to 48 percent. Off take declined quite dramatically particularly after 1998-99 indicating that introduction of the Targeted Public Distribution System, which made a distinction between APL (Above Poverty Line) and BPL (Below Poverty Line) population resulted in a decline in off take.

This is mainly on account of the narrowing the differential between the PDS and open market prices, particularly for Above Poverty Line families. A large proportion of APL families are moving out of the network as the APL (Above Poverty Line) issue price is close to market prices.

Thus, food grain stocks are overflowing because procurement has increased very sharply and the supply to the PDS has plummeted.

Economic Implications of Excessive Public Stocks:

The FCI incurs costs for procuring, transporting, storing and distributing of food grains. The total cost is apportioned between economic cost and buffer carrying cost. The economic cost consists of the acquisition cost (which includes Minimum Support Price etc.) and the distribution cost. Minimum Support Price accounts for nearly 45 percent of the economic cost in case of paddy (common) and 75 percent in case of wheat. State taxes and other procurement incidentals account for about 6-7 percent of the economic cost for rice and about 18 percent for wheat. The rest is storage and distribution cost.

FCI's economic cost of rice and wheat has been rising sharply over the years. Much of this is due to large increase in Minimum Support Price (Table 5).

Table 5: Food Corporation of India's Economic Cost of Rice and Wheat (Rs./quintal).

Fiscal year	*Economic cost*	
	Wheat	*Rice*
1991-92	391	497
1992-93	504	585
1993-94	532	665
1994-95	551	695
1995-96	584	763
1996-97	663	858
1997-98	798	937
1998-99	800	995
1999-00	872	1111
2000-01	830	1148
2000-02	839	1174

Source: Economic Survey 2001-02.

Excess procurement due to higher MSPs and mounting stocks of food grains much above the levels required for food security, have led to elimination of private trade and higher commitments for government subsidy. The food subsidy increased from Rs. 2850 crore in 1991-92 to Rs. 12010 crore in 2000-01. For 2001-02 the estimated food subsidy is Rs. 13670 crore of which 5680 alone constitutes buffer subsidy. The buffer subsidy which was Rs. 1494 crore in 1995-96 has risen to Rs. 4233 crore in just 5-6 years indicating a rise of about 200 percent (Table 6).

Table 6: Food Subsidy (Rs. Crore)

Year	*Food subsidy*	*Buffer components*	*Consumer subsidy**	*Buffer subsidy as % of food subsidy*	*Consumer subsidy as % of food subsidy**
1997-98	7500	937	6563	12.5	87.5
1998-99	8700	1552	7148	17.8	82.2
1999-00	9200	1754	7446	19.1	80.9
2000-01	12010	4233	7777	35.2	64.8
2001-02	13670	5680	7990	41.6	58.4

Source: Economic Survey 2001-02
Author's calculation.

Higher procurement together with the reduced off take witnessed in the last three years has resulted in a much larger buffer stock, entailing much larger buffer carrying costs (comprising freight, storage, interest charges etc.) In 1997-98, the buffer component of the food subsidy was only 12.5%, which has today risen to 42%. Large volumes of unsold public stocks of food grains push up the carrying cost, which raises the subsidy burden thus, aggravating the attempt to contain the fiscal deficit.

Efficiency of Food Subsidies:

It has been recognized in recent years that there are two major issues with the PDS. The first issue is whether the target groups receive significant subsidies from the PDS. The second issue is whether these subsidies are provided efficiently. Roughly speaking, the first issue concerns the scale of the PDS while the second issue concerns the efficiency of PDS expenditure (Ramaswami, 2002). While, for convenience, I will examine these issues separately, they are intimately connected. A higher efficiency of PDS expenditures, scale remaining unchanged is equivalent to a higher scale, efficiency remaining unchanged. In recent years, evidence has steadily mounted that the poor receive scanty benefits from the PDS (Dev and Suryanarayana, 1991; Parikh, 1994; World Bank, 2001). In the southern states, especially Andhra Pradesh, Kerala and Tamil Nadu, the poor seem to make reasonable use of food subsidies (Ramaswami, 2002). This is not so in rest of the country. Indeed, the majority of the poorest 20 percent of households in the northern and eastern Indian states does not purchase any food grains from the PDS (Parikh, 1994).

The poor might be excluded or might not participate for a number of reasons. First, the geographical coverage of the PDS is limited especially in the northern Indian states. For instance, in Maharashtra, 30 percent of the poor do not use the PDS because of lack of access (Dutta and Ramaswami, 2001). Second, to obtain access, households must show proof of residence. This is difficult for migrants. Third, ration entitlements can be accessed only once in fortnight. Often, poor households do not have incomes that permit savings for this duration. Fourth, given the costs of utilizing the PDS, because of factors such as queues, uncertain supplies, inferior quality, and inconvenient location, the slender subsidy (because of limited quotas and subsidy rate) offered in most states might not justify the participation of poor households. In 1993-94, the average per capita subsidy received from purchases of rice, wheat, sugar and kerosene was Rs. 3.5 in rural areas and about 6 in urban areas. The median value of the ratio of total subsidy to household expenditure was less than 1 percent in both urban and rural areas (Tarozzi, 2001).

Another way to judge the importance of subsidy to household would be to look at the subsidy in relation to maximum income that can be transferred to target groups by a food subsidy system. For example, suppose we take 4 kgs of grain per capita per month as desired level of supply from the PDS. If the market price of grain is P, food subsidies can increase per capita incomes by at most Rs. 4P, which happens when supplies are free. Computed this way, Dutta and Ramaswami (2001) find that the bottom 40 percent in Andhra Pradesh receive, through the PDS, about a quarter of the maximum income transfer while in Maharashtra, food subsidies transfer to the bottom 40 percent only about 5 percent of maximum possible levels.

Even where publicly subsidized grain reaches the poor, the market is just as important a supplier. Most households depend on a mix of the two. In a typical pattern, the market is the dominant supplier (Dev and Suryanarayana, 1991; Parikh, 1994; and World Bank, 2001) presumably because ration quotas are limited and not available for purchase continuously. This means that consumer benefits from the PDS depend not just on the scale of subsidies (which are meager for poor households in most parts of the country) but also on how the subsidies impact the market price of grain. If, as the evidence suggests, the PDS increases the market price of food, then these effects may well dwarf the direct benefits of food subsidies.

It can therefore be concluded that, with the exception of a few states, the effect of PDS on the well-being of the poor has been negligible, if not perverse. To register larger benefits, the scale of the program would have to expand to be a major supplier of grain to the poor. Swaminathan (2000) argues that fiscal problems should not constrain expansion as food subsidies are less than 1 percent of GDP, a ratio lower than that of many other countries. As a proportion of central Government expenditure, the central food subsidy fluctuated between 2.5 percent and 3.5 percent (Swaminathan 2000). These ratios would have to increase significantly, perhaps even doubled, for the PDS to make a major difference to the livelihoods of the poor. Such recommendation runs counter to the prevailing concerns about fiscal control. But surely the issue is one of productivity of Government expenditure rather than of it size. In the macro-perspective, the scale constraint to food subsidies stems from unwillingness and inability to undertake reforms of itself so that resources could be released for safety net expenditures.

This brings us to the issue of efficiency of PDS expenditures. If there are potential efficiency gains, reform within the PDS could expand the scale of food subsidies. There are three principal reasons why the PDS does not deliver food subsidies efficiently. These reasons include, income transfers to non-target groups, excessive costs of procurement, storage and distribution and leakages or fraud, i.e. illegal diversions of subsidized grain to the open market.

To get an idea of their quantitative magnitude, we draw upon examples from Andhra Pradesh and Maharashtra (Dutta and Ramaswami, 2001). Suppose the objective of food subsides is to subsidize the food consumption of the bottom 40 percent ranked by income. Table 7 shows how much of the expenditures on food subsidies go to the target group (the fourth column) after accounting for targeting errors (the first column), excessive costs (the second column) and leakages or illegal diversions to the open market (the third column).

Table 7: Decomposition of the Cost of Food Subsidies

	Total expenditure	*Transfer to non target group*	*Excessive costs*	*Leakage/ fraud*	*Transfer to target group*
Andhra Pradesh	7778	2059 (26.5)	2058 (26.5)	1161 (15)	2477 (32)
Maharashtra	1883	568 (31)	295 (16)	529 (28)	468 (25)

Source: Dutta and Ramaswami 2001 (The target group is defined as the bottom 40 percent of the population ranked by expenditure).

Note: Figures in brackets are percentage.

These computations are based on food subsidy costs and estimates of income transfers (from National Sample Survey consumption expenditure data) in 1993-94. These figures imply (dividing the income transfer by the subsidy cost) that it costs Rs. 3.14 and Rs. 4 to transfer a rupee to the target group (of bottom 40 percent in Andhra Pradesh and Maharashtra respectively). These examples illustrate that it costs much more than one rupee to transfer a rupee of subsidy to a reasonably defined target group. It is sometimes thought that targeting errors are responsible for these departures from efficiency. However, Table 7 makes it clear that the costs of delivering food subsidies to the target group are high because of targeting errors as well as lapses in implementation. To see the relative contribution of these factors, consider the cost-effectiveness of transferring a rupee of subsidy to the target group of bottom 40 percent. Suppose targeting were perfect in the sense of zero subsidies to the non-target groups and nothing else changes. The change in cost-effectiveness depends whether the saving are transferred to the target group or to the general budget. In the first scenario (call it case A), costs remain same but effectiveness increases while in the latter scenario, costs fall but the target group receives the same amount of subsidies (case B). The first row of Table 8, reports the cost-effectiveness of perfect targeting. Notice that subsidy transfer still costs more than rupee because of excessive costs and illegal grain diversions, which together can be called implementation failure.

Table 8: Cost of Providing One Rupee Subsidy to Bottom 40 Percent Under Perfect Targeting or Organizational Reform.

	Andhra Pradesh Case A	***Andhra Pradesh Case B***	***Maharashtra Case A***	***Maharashtra Case B***
Perfect Targeting	1.71	2.3	1.82	2.81
Perfect Organizational Reform	1.37	1.84	1.46	2.2

Source: Ramaswami, 2002

The contribution of costs of implementation failure can be considered by a corresponding hypothetical experiment. Suppose these costs were reduced to zero, everything else remaining unchanged. The second row of Table 8 report the cost-effectiveness of organizational reform under case A and case B. Although neither case is completely realistic, it can be seen that implementation efficiency offers at least as much if not greater gain as improvements in targeting.

Targeting:

For public spending in general, the literature makes distinction between broadly targeted and narrowly targeted programs (See Hoddinot, 2001). The idea of broad targeting is to subsidize basic consumption goods and services for all households because such goods and services matter more to the poor. As the poor spend more on food, in proportionate terms, than the non-poor, a universal food subsidy such as erstwhile PDS is an instance of broad targeting. But, as we have seen, such programs also benefit the non-poor and are therefore expensive. Narrow targeting is of two types. The first is indication targeting which identifies an easily observable characteristic of households that is highly correlated with low income. The indicator is then used as a proxy for income to identify and target poor households. The second approach is self-targeting. Here the design of subsidy is such that it is much more costly for the non-target group than for the target group to participate in the subsidy scheme.

Clearly, the success of indicator targeting depends on the correlation of the indicator with poverty. In India, indicator targeting at the central level began with the revamped PDS in 1992 where certain backward regions received higher subsidies. While there is no published evaluation of this program, Jha and Srinivasan (2001) demonstrate the potential of geographical targeting especially when it is done at the district level where disparities are marked. However, geographical targeting was given up in 1997, when it was replaced country-wide by the targeted PDS (TPDS). In the new program, the PDS makes a distinction between Below Poverty Line households (BPL) and Above Poverty Line (APL) households. While APL households are provided grain at FCI's economic cost, BPL households receive grain priced at 50 percent of FCI's economic cost which covers the cost of procurement, taxes, transport and distribution. Thus, the subsidies are restricted to the BPL population (Table 9).

Table 9: PDS Issue Price of Wheat and Rice (Rs/Quintal)

Year	*Wheat*	*% Change*	*Rice*	*% Change*
1990-91	234		289	
1991-92	280	19.7	379	30.4
1992-93	280	0.0	377	0.0
1993-94	330	17.9	437	15.9
1994-95	402	21.8	537	22.9
1995-96	402	0.0	537	0.0
1996-97	402	0.0	537	0.0
1997-98				
BPL	250	-	350	-
APL	450	-	700	-
1998-99				
BPL	250	0.0	350	0.0
APL	650	44.4	905	29.3
1999-2000				
BPL	250	0.0	350	0.0
APL	682	4.9	905	0.0
2000-01				
BPL	415	66.0	565	61.4
APL	830	21.7	1130	24.9
2001-02				
BPL	415	0.0	565	0.0
APL	610	26.5	1130	26.5
		FCI's Economic Cost		
1997-98	799	-	937	-
1998-99	800	-	995	-
1999-2000	872	-	1111	-
2000-01	830	-	1148	-
2001-02	839	-	1174	-

Source: Economic Survey, 2001-02

In principle, TPDS ought to make food subsidies cost-effective. However, it would be naïve to expect targeting errors to vanish. Indeed, exclusion errors are built into the implementation process. Identification of the poor is the responsibility of the state Government, which in turn is expected to use local bodies and village panchayats for this purpose. Even though the poverty line is an expenditure-based norm, it is not feasible to elicit expenditures for identification. Identification would then depend on household characteristics such as occupation, dwelling type and size and so on. Even when done honestly, there is no reason to expect that the total of such beneficiaries will match the BPL population in the state because (a) targeting indicators are imperfectly correlated with poverty and (b) poverty is itself measured with error. If there is an excess of beneficiaries, there is a problem because their BPL subsidy will not be funded by central Government. At least some of the state Governments might be expected to trim the number of beneficiaries by whatever means to match the BPL population. So exclusion errors can expected even when the process is faithful to its intensions. More realistically, we can expect errors also because of lack of interest and capture by non-target groups. In addition, the difference between APL and BPL prices provides strong incentives for illegal diversions to the market. For these reasons, it is not clear that BPL targeting is the best route for target groups to access subsidies.

The difficulties of indicator targeting make self-targeted programs, in which the relatively rich voluntarily opt out of the program, particularly valuable. Self-targeting in food subsidies can work by subsidizing commodities consumed primarily by the poor. Rice and wheat are the main commodities that are subsidized under the PDS. On the other hand, coarse cereals comprising sorghum, pearl millet and maize are known to receive higher shares in the household budgets of the poor in several regions of India. But these commodities are unsubsidized. Would it be welfare improving to transfer one rupee of subsidy from rice and wheat to the coarse cereals? Since the importance of coarse cereals varies by state and residence, the answers to this question must be state specific as well.

Thus, the general point is that self-targeting schemes cannot work on an all-India basis because it used food preference patterns that are necessarily state-specific. Coarse cereals are in particular not suited to a centralized procurement, storage and distribution because of their limited shelf life. However, subsidizing coarse cereals could work as a component of a regional food subsidy program.

Food Stamps:

A feature of India's food subsidy program is the deep involvement of the Government and its agencies in physically handling the grain. The government buys the grain, stores it in its warehouses, transports it to different depots in the country and distributes it to authorized retail outlets. Agencies of the central and state Governments carry out this operation. An alternative to such an arrangement is the system of food stamps. In this scheme the purchase, storage, movement and distribution of grain is performed by the private sector. Could this be superior to the existing PDS? As there is no published work that has examined this question, consider the factors that will matter in the cost benefit calculus.

A food stamp is a cash voucher, which can be exchanged by the recipient for only food.

It is usual to restrict the list of foods by excluding alcoholic beverages, snack food and processed food. Here consider food stamps that can only used to purchase food grains. In order to preserve comparability with the PDS, assume a food stamp program that offers recipient the same level of subsidy as the PDS.

We noted earlier how targeting errors, excess costs and illegal diversion erode the cost-effectiveness of the PDS. How could food stamps be better or worse? Like the PDS, a food stamp program also requires the identification and registration of beneficiaries. Food stamps are therefore on the same footing as the PDS with respect to targeting errors. Excess costs, which constitute a significant part of government subsidies, cannot arise in a food stamp program since the grain is transacted through private markets. This is the major gain from a switch to food stamps from PDS. A leakage in terms of diversion of grain is clearly not an issue with food stamps. However, other kind of fraud might still occur. In particular, food stamps meant for identified beneficiaries might be hijacked by intermediaries and sold to non-target groups (or to target groups themselves resulting in loss of subsidy). As food stamps are like currency, diversion of food stamps might be easier in terms of transactions costs than the diversion of grain. With respect to fraud, it is not clear, a priori, whether food stamps are more advantageous than PDS. However, as food stamps can be numerically tagged, it might be cheaper to inspect and investigate food stamp fraud than illegal grain diversions. Finally, all of this discussion assumes the existence of a private retail grain-marketing network. Food stamps might not work in remote regions with poor transport links although it must be acknowledged that these factors work against PDS as well.

Policy Response:

India's food market intervention is in crisis. Unable to resist procurement lobbies, public money in the last decade has been used to build grain stocks, subtract supplies and increase food grain prices. Neither is there much compensation in terms of an effective distribution system. With the exception of the southern states, too few of poor use the PDS and the bulk of subsidy is masterfully spent on transfers to non-target groups, illegal diversions and inefficient in distribution.

While the PDS is the joint responsibility of the central Government and the state Government, their roles are unequal. The central Government procures, stocks, transports and supplies grain to the state governments and absorbs the costs of these operations. Once the grain is allocated to the states, it is job of the state Government to lift the grain and distribute it to retail PDS outlets within the state. Decision about the major policy parameters (procurement price, issue price, ration quotas) are vested with the central Government. Some state Governments, have participated in policy-making (with, of course, influence restricted to their domain) by offering subsides in excess of the central Government subsidy. But, by and large, the role of state Governments is to support the FCI in procurement and distribution with little participation in policy-making except by way of lobbying for special interests.

It is unlikely, however, that this will remain unchanged. A more federal structure seems to be in the offing. The first step in the evolution was targeted PDS. The principal innovation i.e. the implementation of targeting does not involve the central Government at all. For the central Government, the major consequence of TPDS is that it ties the central Government subsidy to BPL population within a state thereby providing a formula for the transfer of food subsidy funds to the states. The second step that the central Government is pushing for is decentralized procurement. If this happens, the implementation of the PDS will be the sole responsibility of state Governments and the central Government will restrict itself to the financing. The advantage of these arrangements for the central Government is that (a) as funding under TPDS is tied to poverty estimates, it is bounded and will decline with falling poverty and (b) decentralized procurement will undermine the power of procurement lobbies, and thereby reduce procurement price, stocks, the economic cost of FCI and hence reduce food grain subsidies as well.

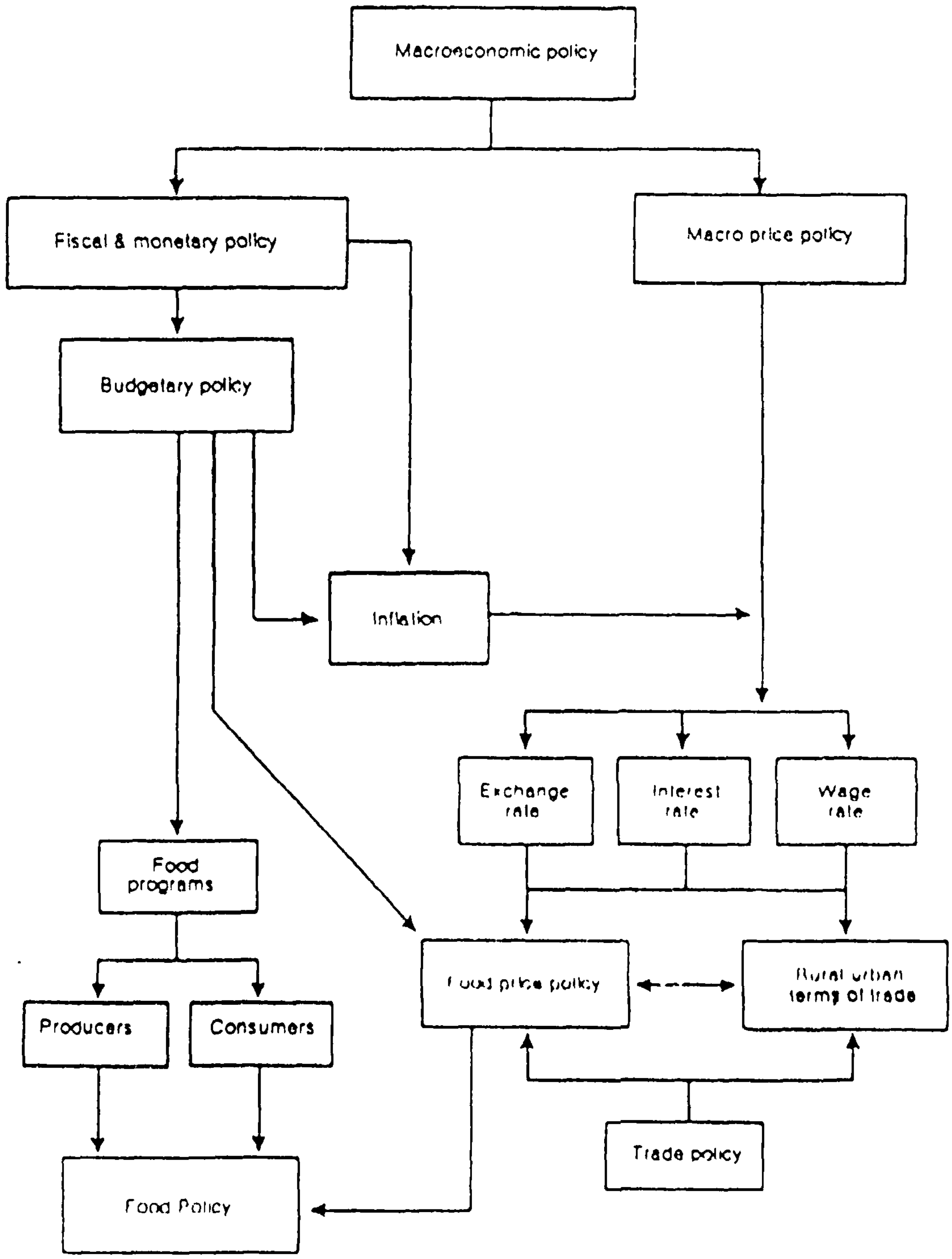
Decentralized procurement has not found favor with the states. While opposition from the grain surplus states expected, other states too have not welcomed it either because they do not wish to confront a procurement lobby in their backyard or because they are unsure about their capabilities in undertaking this operation. It is also not clear how decentralized procurement will mesh with minimum support prices. If these are obligatory for state Governments as well, predominantly grain-deficit states might not save much by undertaking procurement themselves. With these uncertainties, it is reasonable for the states to resist decentralized procurement.

Although the evolution to a federal relationship seems, ironically, to suit the center more than the states, there are opportunities especially for the states that are committed to the PDS to gain control on food subsidies and to restructure them efficiently. It is well known that PDS performance differs across states which suggests that local factors matter and should therefore be taken into account in food subsidy policy (Ahluwalia, 1993; Dev and Suryanarayana, 1991; Dutta and Ramaswami, 2001; Mooij, 2001 and Parikh, 1994). Indeed, while there is enormous scope for improving efficiency by reforms such as geographic targeting, self-targeting and food stamps, their design and effectiveness are specific to local preferences, knowledge, infrastructure and circumstances. For instance, a state could subsidize coarse cereals, use food stamps in urban areas, allow universal access in backward areas, and temporarily increase the subsidy rate in regions that are adversely affected by floods, drought and other natural disaster. In a decentralized framework, the central Government would primarily be limited to the storage of emergency reserves. Through the Planning Commission, the central Government could monitor the targeting performance of individual states and reward the states that do well with greater subsidy allocation irrespective of their poverty status for it can be masterful to allocate subsidies to poor states without regard to targeting performance (Mooij, 1999). States with little interest in food subsides will languish with ineffective distribution. But this is an outcome that has to do more with state politics than with central policies.

Such a move towards a federal relationship in food subsidies is essential if the food subsidy system is to be flexible and contingent on local circumstances and needs. It need not result in the central Government abandoning its responsibilities, as some critics fear, provided the state Government negotiate with the central Government to ensure the scale of financing is commensurate with the needs of a secure safety net. Indeed, this ought to be the major agenda of the states.

The major hurdle to a federal structure is the tricky issue of procurement. The practical difficulties in decentralizing are much exaggerated. After all, private trade does move grain from the surplus to the deficit states. It is immediately feasible for the states to constitute a clearing house (which invites bids for purchase and sale from FCI as well as private trade) that matches the demand with supply. The more durable difficulties are political. There is proposal of income support to replace procurement. But this would only exchange the present troubles for future problems of an even greater magnitude.

Figure 1: Major connections Between Macroeconomic Policy and Food Policy



Source: C. Peter Timmer, 1985.

Chapter 7

Globalization and Its Impact on Indian Food Security

What is Globalization?

Globalization means "the multiplication and intensification of economic, political, cultural, and environmental linkages, between people, organizations, and nations. As a result of process of globalization there is increasing tendencies towards universal application of economic, institutional, legal, political, and cultural practices and the presence of significant global spillover from the behavior of individuals and societies. Globalization is influencing trading patterns, capital flows, resource allocations, and market structures" (Bonila and Robinson, 2001).

In common usage, the notion of globalization encompasses a wide range of phenomena from economic activities to the internationalization of (mainly Northern) culture, education, technology and tastes. Globalization refers both to the integration of production facilities in different countries under the aegis or ownership of the multinational corporations and the integration of product and financial markets facilitated by liberalization (South Center, 1996).

Trade liberalization is a process of systematically reducing and eventually eliminating all tariff and non-tariff barriers between countries as trading partners. It builds on the theory of comparative advantage in a free market, which holds that countries will benefit more if they focus their resources on sectors in which they have some sort of advantage and that the free market is the best mechanism for ensuring the optimal allocation of resources. The wealth generated as a result will benefit the economy as a whole. The theory has nothing to say about winners and losers within national economies. (Modeley and

Solagral, 2001).

For developing countries in general and India in particular. The central elements for selecting proper road are provided by the agricultural sector. Under a more market-driven economic policy framework, agriculture is capable of facilitating trade expansion and GDP growth, while also helping to generate incomes and job for the poorest part of the population, facilitate more appropriate land and natural resources practices, and provide broader social benefits within an increasingly decentralized political framework. However, because of the deep-rooted legacy of old paradigm based on import substitution, fundamental institutional adjustment and structural changes will be required before agriculture can respond fully to the new opportunities. Thus, the role of agriculture in the new global order must be central if broad-based growth is to occur.

A dynamic agricultural sector seeks to expand, in a cost effective and risk reducing way, linkages with input supply, post-harvest processing and handling, distribution and manufacturing in order to maximize broad-based economic opportunities. The overall agricultural environment must be conducive to the changing requirements of producers and rural residents as they respond to the needs of increasingly distant consumers and competitive producers and agribusiness. These shifts must also embrace the increasingly complex environmental issues effecting natural management and public health. Thus, there is need of critical, mutually supportive elements considered essential for government to respond adequately to changing time.

Globalization, Poverty, Food Security and Agriculture; Linking the Pieces

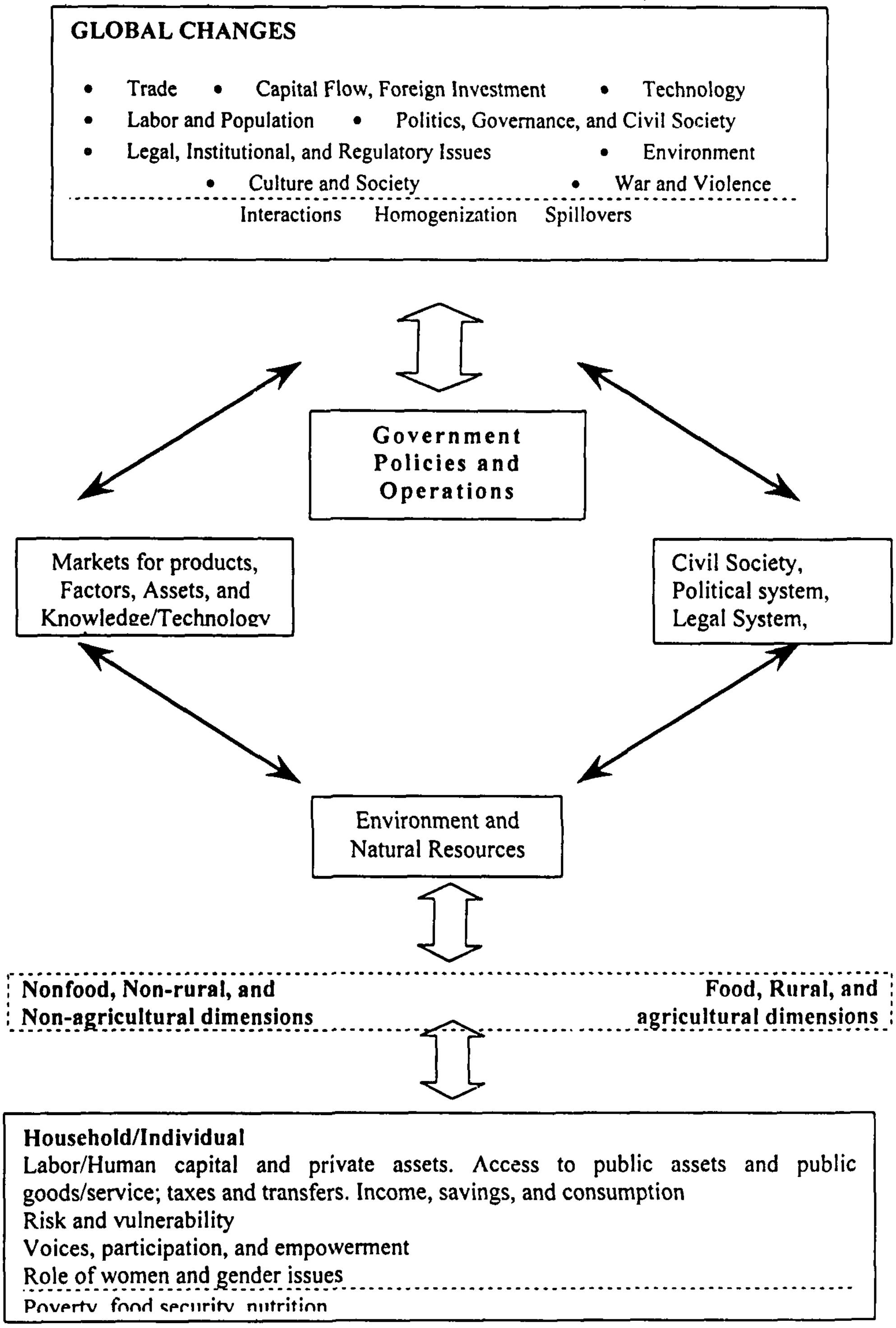
Globalization may change the use, and relative value of the economic assets and capabilities of the poor. It may also have an impact on non-economic assets and capabilities, such as social capital (civil contacts, networks, and institutions) and political processes that determine the participation and empowerment of the poor.

The food and agriculture in developing country is inseparable from the rest of national economy and the world market. Changes in world markets affect national economic growth, and change in non-food policies affect the performance of food sectors. No country grows everything it wants or needs to eat so trade is an integral part of the quest for food security. How international trade structured, how macroeconomic policies position agriculture within a national economy and that national economy within the global markets system these have always been critical questions for reducing hunger but they have become more important as globalization accelerates. The transformation of rural economies from subsistence to commercial and national economies from closed to open can create hardship for many. Guiding this transformation and its accompanying development of market and supporting infrastructure and institutions is critical. How to guide these transformations so that they can best contribute to agricultural growth, poverty alleviation and food security is critical (IFPRI, 2001).

Food and agricultural framework in developing countries connect with the rest of the economy and with the world through a network of markets. Changes in world market directly affect national economies and changes in domestic nonfood policies indirectly affect food sectors.

The outline framework linking globalization, agriculture, poverty, and food security is presented in the figure 1. Different dimensions of globalization are listed at the top (first level) and are shown as affecting the government, civil society, markets, and environment in developing countries (second level). For instance globalization may influence the autonomy of government policies and availability of public resources. It may affect the cultures and values while allowing new cross country alliances in civil society. It may change the actors in and the structure of markets domestically and internationally and may lead to larger environmental spillovers. In turn, these changes have implications for different sectors: agriculture/industrial, rural/urban, food/non-food (third level). Finally, the different dimensions of globalization affect poverty through their impact on economic and non-economic assets and capabilities, mechanisms for the redistribution of income, and institutional factors (fourth level).

Figure 1: The Links Between Globalization, Poverty & Food Security.



Source: Bonilla and Robinson, 2000.

Present Liberalization in Historical Perspective:

The processes of liberalization and globalization have occurred at different speeds and to varying extents in different regions and countries following the Second World War. In order to comprehend the magnitude of the changes under way, an overview and comparison of the overarching economic systems of 1950 to 1970s and the 1990s is necessary This is story of paradigm shift, where government led economic growth through the 1970s gave way to the increasingly market-led growth we see now. The centerpiece of the new paradigm is the rapid global shift from closed, nationally focused markets (protected and subsidized) to open, global markets (competitive and less subsidized).

Advanced Countries:

In the world economy following the Second World War, these processes have occurred at different speeds and to varying extents in different regions and countries. Both liberalization of trade and freedom of capital movements have been implemented to the greatest degree in advanced economies. Trade in manufacturing products among these countries was liberalized gradually over the whole of the post-war period through successive rounds of international trade negotiations (up to and including the Uruguay Round). By the mid-1970s, at the conclusion of the Tokyo Round, the weighted average tariff on manufactured products traded among industrial countries was only 6.5 per cent, compared with 10 per cent before the Round. In 1990, this figure was down to 5 per cent.

The liberalization of capital movements among advanced economies has also occurred in stages, but in somewhat different ways than the deregulation of foreign trade. In many respects capital market liberalization between these countries has gone further than trade liberalization. Most of these economies achieved current account convertibility in the late 1950s. However, capital account convertibility in leading industrial countries took place only in the 1970s in, for example, the United States, Canada, UK and Germany and in 1980 in Japan.

France and Italy introduced capital account convertibility only in 1990. Capital account convertibility in the advanced countries came in the wake of the collapse of the Bretton Woods fixed exchange rate system. It was preceded by the liberalization of domestic financial markets in these countries. These were important steps in the integration of international financial markets, which many in the financial world regard as being synonymous with globalization. (The integration of markets refers to the fact that the various national markets for a product or financial service become in effect one single international market.) The foreign exchange market was the first financial market to globalize in the mid-1970s; it is the biggest and perhaps the only truly global financial market. The integration of stock markets occurred later still with the deregulation of domestic stock markets in leading countries. A notable example of this was the so-called "Big Bang" in London in the mid-1980s, involving the simultaneous abolition of a large number of the rules and regulations which traditionally had governed the conduct of members of the stock market and the criteria for membership.

Liberalization has been much less evident with respect to flows of labor between countries. Moreover, unlike trade and capital movements, over time there has been retrogression in this sphere in many industrial countries. Nevertheless, it is important to appreciate that, as a part of the process of privatization, deregulation and market ascendancy in general, in the post-1980 period there has been a considerable relaxation in the domestic rules and regulations maintaining labor standards, minimum wages and labor rights. The European country, which has gone furthest in this direction, is the United Kingdom.

Developing Countries:

Compared with the situation in advanced industrial countries, both globalization and liberalization have occurred at a slower pace in developing countries. An outstanding feature of the post-1945 international economic arrangements was the special and differential treatment accorded to developing countries in recognition of their economic backwardness. This apparent altruism was very much the product of the Cold War and contention between the two economic and political systems liberal capitalism represented by the United States and the state-planning system of the former USSR (Glyn, Hughes, Lipietz and Singh, 1990). In the face of pressures from the G-77 following the creation of UNCTAD, "non-reciprocity" in trade relations was accepted in the GATT by industrial countries, whereby they agreed to provide comparatively easier preferential access to their markets for developing country goods (those under the Multi-Fibre Arrangement were an important exception), whilst permitting developing countries to impose tariffs on advanced country products.

The Uruguay Round Agreements and the establishment of the World Trade Organization

(WTO) greatly reduce the scope of this concession and they reflect the changed world political situation following the end of the Cold War. The efforts by the North to engage the South in negotiations on trade and trade-related matters represented the North's efforts to respond to Southern competition by demanding greater reciprocity as well as other measures that would further pressurize the North's economic interests.

However, even before the Uruguay Round Agreements came into force, many developing countries had begun in the 1980s to reduce their tariff barriers. The impetus for these reforms emanated from two interrelated sources. First, they were an integral part of the new policies of the multilateral financial institutions, particularly the World Bank, whose structural adjustment lending programs were conditional on economy wide policy reforms in developing countries, including trade, foreign investment and financial sector reforms. Secondly, the economic failure and the "lost decade" of the 1980s (largely due to the debt crisis) in Latin America and sub-Saharan Africa obliged many countries to accept these conditionalties, as well as similar ones imposed by the International Monetary Fund (IMF). According to the World Bank (1990), which reviewed the structural conditionality for loans made during the period 1980-1987, nearly 80 per cent of loans required trade policy reform and nearly 40 per cent liberalizing reforms of the financial sector. This is not to suggest that some countries did not introduce these reforms under their own initiative, ascribing their recent economic failure to their former dirigisme and relatively closed economic regimes.

Thus, for example, Mexico reversed its successful import substitution of the previous four decades and acceded to GATT in 1986, reducing its tariffs to an average of 11 per cent by 1988. (Rodrik, 1992.) Other Latin American countries also turned to neoliberal policies, attributing their economic failure to their past policies of dirigisme and import substitution rather than to the external shocks over which they had no control. However, dirigisme and import substitution were also practiced by the highly successful East Asian economies.

Similarly, in the 1980s and the 1990s many countries have greatly liberalized their foreign investment regimes, as well as reduced their controls over capital movements. Also, despite their doubtful merits for economic development (Stiglitz, 1994), stock markets have been established or expanded as part of financial sector reforms around the globe, even in the poorest countries. Such markets have been used in many countries to facilitate privatization, attracting in the process substantial foreign portfolio capital. This, of course, involved changes in long standing policies against foreign ownership.

There is, however, an important difference between the trade and financial policy reforms carried out by the "unsuccessful" economies such as those in Latin America and the "successful" ones in Asia in the recent period. Countries in the two regions have carried out many similar reforms, but the process in Asia has been voluntary, gradual and guided whereas in Latin America it has usually been forced on them by the debt crisis and World Bank and IMF conditionalities, and these reforms have usually been introduced in a precipitate and wholesale fashion.

Despite the widespread implementation of trade policy reforms in developing countries since 1980, it is significant that the extent of trade liberalization implemented by most of these countries is still quite limited.

To sum up, liberalization and globalization both in industrial and in developing countries have been cumulative and uneven processes extending over many years. But even industrial countries have a long way to go before they can be regarded as being fully liberal in the ideal neoclassical sense, that is, that firms' decisions no longer need to take into account national boundaries and that rates of return to factors of production are equal world-wide, subject only to differences in transportation costs and degrees of risk.

Nevertheless, at a practical level, with respect to trade in manufactures and capital movements between leading industrial countries, there can be deemed to have been more or less free trade and capital movements in the last ten to fifteen years. This is especially so, not only in comparison with the developing countries but also, more importantly, in comparison with the situation in these economies themselves in the 1950s and 1960s. During these earlier decades most countries not only enforced international capital controls under the Bretton Woods regime, but their domestic product, capital and labor markets were also subject to a wide range of rules and regulations in keeping with economic and social objectives.

Liberalization, Poverty, Agriculture and Food Security: A Review of Case Studies

Liberalizing agriculture markets can encourage agriculture-led economic growth in developing countries, many of which have experienced higher levels of input use, increased production, expanding exports, and higher incomes as a result of more open markets. But countries moving toward a commercial, market-oriented economy face a complex task. Without over sight, ineffective policies, weak institutions, and inadequate infrastructure can create market inefficiencies. Liberalization can result in dramatic changes in products, income distribution and labor in ways that may harm the poor. The transformation of the rural economy can cause hardship for smaller farmers who cannot meet new production standards or who lack credit or specialized knowledge. We need to ensure that globalization does not make exceptions and boxes, but follows rules of global interaction and cross-border interaction that are dedicated to sustainability and people.

The impact of trade liberalization over the past twenty years, since the introduction of structural adjustment programs in the early 1980s, and especially since the setting up of the World Trade Organization (WTO) in 1995, has become one of the most hotly contested debates in international economic policymaking.

The advocates of liberalization, often represented by the WB, IMF, WTO and a number of academics, call for liberalization to continue but also for policies to address the negative side effects of liberalization. They also call for the removal of trade-distorting subsidies and protectionism on the part of developed countries. They believe, that trade liberalization contributes to the alleviation of poverty, increases prosperity and speeds the development process. They also argue that the impacts of regional trade agreements are generally creation of trade and increase welfare. Gains are larger when developing countries can link up with an economy that is rich, large, or both.

According to a comprehensive assessment (World Bank, 1996) of major structural shifts beginning in the mid 1980s and subsequently accelerating, in most countries saving and investments have increased, inflation has decreased, foreign exchange rates have been stabilized, fiscal deficit reduced, and real interest rates established (World Bank, 1996).

A paper on trade policy for the Dominican Republic by the WB, recommends, "Increased openness to trade is one of the most important pending policies to sustain strong economic growth in the Dominican Republic." The paper suggests that trade reforms can play an important role in supporting growth by making modern technology more profitable for domestic firms and by increasing specialization. Also, by reducing the implicit and explicit tax on exports, trade liberalization would provide an added boost to tourism and help develop more efficient and outward looking agriculture and industrial sectors. The paper goes on to state that; "failure to proceed with liberalization in the agriculture sector will limit the benefits of this reform, especially for the poor. The government would be well advised to pursue a gradual but more aggressive policy towards trade liberalization while providing adequate safety net mechanisms to the most vulnerable farmers. In this same area, even if in the short run current high protections were to be maintained, the country and the government would benefit by a more transparent management of non – tariff barriers (Ingco, 1997)."

Another paper by the International Monetary Fund, Malawi (IMF, 1998/99-2000/01) notes that Malawi's first democratically elected government adopted a set of prudent financial policies with complementary structural reforms which were initiated to liberalize the economy and redirect public spending to priority areas such as health, education and agriculture in order to alleviate poverty. This paper also notes that the liberalization of agriculture brought benefits of high growth accruing primarily to the smallholder farmers, most of whom, belong to the poorest segment of the population.

Another study by the WTO secretariat (Dan and Winters, 2000), concludes that 'trade liberalization is generally a strong positive contributor to poverty alleviation. It also acknowledges that some people do lose in the short run from trade liberalization, and argues that the plight of the losers should not be ignored, and that it should be addressed with proper social safety nets and job retraining 'rather than by abandoning reforms that benefit most people'.

According to Dollar and Kraay (2000), openness to international trade "raises income of poor by raising overall income, with insignificant effect on distribution of income".

Ferreira, 1996 in a paper entitled "poverty and inequality during adjustment in rural Tanzania" claims that growth attributed to structural adjustment benefited the population generally "shifting a significant portion of the population from below the poverty line to above it. Only that smaller fraction of the population with extremely low income was unable to benefit from the economy's improved performance, probably because the liberalization process that encouraged growth rewarded those with education, excluding from benefits those with little education".

Besides these positive views about trade liberalization there are a series of negative perspectives on the Impact Of trade liberalization.

The report of a UNU – UNDP project (Ginkel, 2000), that compiled all available data on inequality trends into the World Income Inequality Database (WIID), based on data from 149 countries, shows clearly that 'inequality has risen in most countries since the early-mid 1980s.' 'What caused the increase? The project analyses indicate that, to an important extent, the rush to implement liberalization policies in the absence of adequate regulatory capacity triggered the recent surges in inequality.'

WB paper (Lundberg and Squire, 1999), finds that greater openness to trade is 'correlated negatively' with income growth among the poorest 40% of the population and 'strongly and positively' with income growth among the remaining 60%. 'While greater openness benefits the majority, it harms the poorest. The results based on a sample of 38 countries between 1965 and 1992 are both strong and striking.

A Symposium on Agriculture, Trade and Food Security by the FAO on 16 countries and their experience in implementing the WTO/AoA finds that the implementation of AoA has led to a surge of imports but no corresponding increase in their exports, and this is forcing local farmers out of business. On the overall impact of the 16 countries, the study says: 'a common reported concern was with a general concentration of farms, in a wide cross – section of countries. While this led to increased productivity and competitiveness with positive results, in the virtual absence of safety nets the process also marginalized small producers and added to unemployment and poverty. Of the 16 countries studied, only Thailand that saw its food exports increase since the implementation of the WTO/AoA (FAO, 1999).

Another FAO study (Weeks, 1997) found that liberalization had no real impact on growth of exports in general. This study on five Central American countries shows that in most respects the five countries did far better during the interventionist period (the1970s) than they have fared since liberalization. Only in Costa Rica did liberalization coincide with a rise in net agricultural exports.

Only certain type of farmers benefit from globalization, 'the benefits of globalization/liberalization to low-income agricultural producers are likely to be very limited. The greatest scope for increased trade is in relatively high- value sub-sectors such as horticulture; but their relative capital intensity limits the scope for low income producers to benefit' (UNCTAD, 1996).'Where additional agricultural income (brought about by globalization/liberalization) is concentrated in the hands of larger producers, and/or liberalization gives rise to an increase in the concentration of land ownership, an increase in overall poverty is possible.' It quotes Mindanao, Philippines as an example 'many of these factors (limited availability of capital, credit, technology and inputs) are compounded by the potential short-term costs of liberalization (UNCTAD, 1996).

The International Fund for Agriculture Development (IFAD) quoted the example of Chile where the boom in exports of fruit from Chile's central valley, partially reversed the impact on land structure of a 1968 land reform as capital and information requirements discriminate against small landowners. Small-holders, especially the recent beneficiaries of the land reform, could not make the large initial investments in fruit trees with no return over an extended gestation period, nor the investments in standardized production and packaging, and were rarely able to obtain credit. They also lacked the necessary technical expertise in fruit production. But at the same time, since fruit production is fairly labor intensive, demand for labor rose significantly, providing employment for many poor households (IFAD, 2000).

In a critique of the Dollar and Kraay paper, the Washington-based center for Economic and Policy Research point out that the growth slow down of the last two decades, which has coincided with increasing globalization, should cause economists who advocate indiscriminate opening to trade and financial flows at least some cause for reflection, it may means that some of the development strategies that have proved successful in the past will require a wider range of intervention and flexibility on a number of policies.

Reforms in Madagascar seem to have hurt the rural poor despite the increase in their food output. Following reform, agriculture grew at fastest rate, which it had (albeit still at a modest rate), with growth concentrated among the smallest farmers. But the evidence also shows deepening poverty during and following liberalization, particularly in rural areas. Nutritional, educational and spending data all suggest significant deterioration in living standards among the country's primarily rural poor. An important cause appears to be the significant liberalization induced rise in all the major food prices, particularly rice, says draft of the World Development Report 2000, which did not appear to the final version of the report.

In short much of the literature reviewed here found that trade liberalization has different impacts on different groups. While most studies suggest that, on balance, the general population will benefit, they also find that it is the poor who experience greatest difficulty. And, within the poor, certain sub-groups, namely small farmers, women and children suffer the most. Small Farmers is the group, which faces hardest hit by trade liberalization in the agricultural sector, by Structural Adjustment Programs, regional trade blocks and WTO AoA-led measures.

Chain of Economic Reforms in India:

Since July 1991, the Indian economy has witnessed a series of reforms, encompassing all major sectors of the economy (agriculture, industry, trade, foreign investment and technology, public sector, financial institutions and so on), it has marked a steady break from the past policy regime. The import substituting development strategy, hitherto nurtured by the Indian planning regime since 1951, was given up in favor of an export-linked strategy. India could no more keep aloof from the rest of the world, particularly if technological advances occurring elsewhere were to be assimilated and adopted to India's own production requirements. And then came WTO on January 1, 1995, because of which India got further integrated into global economic system and become adherent of multilateral trade system. Finally, beginning April 1, 2000, all types of quantitative restrictions on imports nearly completely removed since April 1, 2001, exports and imports are now free of all restrictions.

It is nonetheless important to emphasize that in the post-Independence history of India's economic life, the 1990s were a markedly different development decade where practically the whole of the old policy fabric that had doggedly endured itself since the beginning of the planning era in 1951, came under change. Foreign investment is now invited by all regions of India, in a wide range of areas, most significantly for removing the so-called infrastructural bottlenecks. Investment collaborations are negotiated by the hundreds. Technology import is no more a forbidden word. The public sector is shedding its unproductive weight while the private sector, mature enough as it is believed to have grown by now, has entered some of those difficult and strategic areas that were once considered to be far beyond their investment capability. National priorities are now being worked out in terms of international market calculations, getting the prices right, both nationally and internationally is given out to be the infallible panacea for growth, employment and economic welfare. Exports and imports are now free of the regulations that were once taken to be a big hurdle in growth and trade expansion. Every sector of the Indian economy is now attuning itself to the changing economic environment. The state itself struggling to demarcate the balance between development and welfare functions.

Every section of Indian economy is now linked with the world outside, either through its direct involvement in international trade or through its indirect linkages with the export transactions of other sectors of the economy. The new policy regime is much important, and relevant, to farmers, industrialists, traders etc. It hardly needs to be emphasized that all categories of economic functionaries engaged in production and services sectors have to adjust to the changing technology-intensive investment, production, labor management and market requirements, dictated partly by compulsions of internal competitions and partly by international commercial pressure (Chadha and Sahu, 2002).

Macro Economic Reforms and Indian Agriculture:

In June 1991, faced with severe fiscal and trade imbalances and double digit inflation, the government officially ended four decades of government led growth and embarked on a new approach that emphasized stabilizing the economy, reforming the investment, trade, tax regimes, the financial sector, and public enterprises; and giving private sector a much greater role in India's development.

With the liberalization of exchange rate and opening up of the economy, the terms of trade for agriculture have shown a significant improvement (Table 1).

Table 1: Index of Net Barter Terms of Trade and Food grains Terms of Trade.

Year	*Net Barter Terms of Trade*	*Food grains Terms of Trade*
1990-91	98.5	94.0
1991-92	104.6	100.00
1992-93	103.3	102.00
1993-94	100.0	100.00
1994-95	103.3	101.5
1995-96	103.6	101.5
1996-97	104.8	107.2
1997-98	101.5	103.1
1998-99	106.3	104.8

Source: Thamarajakshi, 2000.

However, despite favorable environment created by macroeconomic reforms, including trade liberalization, in the 1990s the average growth of GDP in agriculture and allied sector slowed down in post reform period when compared to the preceding decades (Table 2).

Table 2: Growth Rates of GDP in Agriculture and Allied Sectors and Total GDP (Post and Pre Reform Period)

Period	*Agriculture and allied sector*	*GDP total*
Pre reform period (1980-81 to 1990-91)	4.66	5.79
Post reform period (1991-92 to 1999-2000)	2.78	5.61

Source: Economic Survey 2001-2002.

Why agriculture supplies failed to respond to this favorable incentive framework? The reason lies on shortfalls in public investment and in the provision of agricultural services. The experience of 1990s clearly demonstrates that far from trade liberalization dampening the performance of agriculture, the failure of public investment and effort is responsible for the inability to benefit from trade liberalization by stepping up and diversifying agricultural output in a cost-effective way (Hanumantha Rao, 2001).

The second major reason is the high domestic support being provided to agriculture in the developed countries, especially the European Union in the west and Japan in the east. Apart from restriction on the imports of farm products through various tariff and non-tariff barriers, this support consisted of measures such as high support prices for farm produce and export subsidies, which are now shifted to direct measure for income support such as deficiency payments in the US, and compensation to farmers in the European union via acreage and headage premiums which exempt from reduction in the domestic support (Table 3).

Table 3: Agriculture Subsidies in Selected Developed Countries.

	Base year (1986-88)		*1997*		*1998*		*1999*	
	Per farmer	**Per hectare**	**Per farmer**	**Per hectare**	**Per farmer**	**Per hectare**	**Per farmer**	**Per hectare**
Canada	12000	75	7000	42	8000	48	9000	52
Japan	15000	10048	21000	10211	22000	10005	26000	11792
USA	17000	98	12000	73	19000	116	21000	129
EC	11000	187	10000	189	11000	209	11000	218

Source: Departments of Agriculture & Co-operation: Statistics at a Glance, 2000.

The reason behind tendency to subsidized agriculture in the developed countries is growth of interest groups, which are coming in the way of the operation of Ricardo's principle of comparative advantage.

The demands for farm products at higher levels of income respond little to changes in incomes and prices. This explains why a small increase in farm output results in more than proportionate fall in its price. Thus farm income declined very often in developed countries despite, and indeed owing to the rise in farm output. This was the genesis of support prices to the farmers. The problem was mitigated to some extent by finding markets for the export of food grains. However, the rising support prices perpetuated high cost agriculture primarily because there was little incentive to shift resources from agriculture, especially labor, whose opportunity cost rose on account of overall development and rise in wages. In the US, for example during the period 1992-97, agriculture accounted for a mere 2 percent of GDP, but employed 4 percent of total labor force. On the other hand, the services sector, which accounted for 72 percent of GDP, employed 63 percent of labor force. The productivity of labor in agriculture is thus comparatively much lower. The position is similar in countries constituting European Union: Over the corresponding period agriculture contributed 2 percent of GDP in France with 6 percent share of labor force; in Germany agriculture's contribution to GDP was 1 percent with 3 percent share in labor force. The corresponding figures for UK were 2 percent and 3 percent (World Bank, 2000). There is thus deterioration in the relative productivity of labor in agriculture in US and countries of EU on account of high farm support. The food surpluses of the farmers produced at high cost could not become competitive in the export market without heavy subsidies on export (Hanumantha Rao, 2001).

One wonders how governments in countries where a mere 3 to 5 percent of total labor force is employed in agriculture have to succumb to pressures from farm lobbies. Part of explanation, of course, lies in the sheer ability of these rich countries to foot the bill. Another reason is that since agriculture in these countries is highly input incentive, a large complex of agro-industries having backward linkage with agriculture as input supplier constitute the highly organized and vocal sections of these farm lobbies. Moreover, these countries are, in any case, incurring huge expenditure on social security for the unemployed in the rest of the economy. The differences is that in case of farm sector, these payments take the form of compensation for lower prices, thus providing incentive for committing resources beyond what would otherwise have been allocated if farm prices were allowed to be determined by market forces.

Welfare Effects of Agricultural Trade Liberalization:

Trade liberalization would generate significant net economic benefits. Taking into account the benefits to producers and consumers and tax saving resulting from removals of subsidies, liberalizing trade in agricultural commodities would generate global benefits of 35.7 billion in 2020 (Table 4).

Table 4: Effects of Global Trade Liberalization on Welfare, 2020.

Region/ country	*Gain from global trade liberalization*		
	Total value (billion of US $)	**Share of Value of agri. prod. %**	**Share of GDP %**
World	35.7	3.0	0.07
Developed Countries	14.2	3.0	0.04
United States	4.3	2.5	0.03
Europe (EU-15)	4.2	3.0	0.03
Japan	3.0	22.3	0.04
Developing World	21.5	3.0	0.14
Latin America	3.0	2.1	0.07
WANA	2.3	5.9	0.13
SS Africa	4.4	10.4	1.03
China	3.6	1.3	0.11
Other East Asian Countries	2.4	36.7	0.18
India	2.1	1.9	0.14
Other South Asian Countries	1.3	3.3	0.36
South East Asia	2.5	3.5	0.15

Source: IFPRI, IMPACT Projections, Rosegrant et al June 2001.

Both developed and developing regions benefit, with the former gaining US $ 14.2 billion and the later US $ 21.5 billion. Although these gains are not large compared with GDP, in many regions they are significant compared with the value of agricultural production.

In fact this type of simulation capture only a portion of the potential effect of trade liberalization. If removing trade barriers simulated overall economic growth by boosting industrial production, it would also have large effects on agriculture and food consumption.

Globalization and Food Security in India:

The links between globalization, poverty and food security in the short-term are less clear. While opponents of trade liberalization maintain that Agreement on Agriculture Under WTO, deteriorate food security situation in the developing countries, "the evidence does not lend credence to the view that trade liberalization would endanger India's food security. Achievement of effective food security when enough stock of food grains can be accumulated, thanks to India's comparative advantage in respect of major cereals, hinges basically on raising the purchasing power of the poor through the generation of employment opportunities" (Hanumantha Rao, 2001).

Table 5, shows Per Capita food availability, percentage and number of malnourished children in 1990 and 2020 (under different scenarios in 2020). Under scenario of trade liberalization Per Capita food availability increases by 16 percent over the availability of 1990, at the same time percentage and number of malnourished children will reduce by 24 and 35 percent respectively between 1990 and 2020. Other scenarios provide some differences but they are unlikely to happen under special social and economic circumstances of India.

Table 5: Per Capita Food Availability, Percentage and Number of Malnourished Children In India, 1990 and 2020: Various Scenarios.

Scenario	*Per capita food availability (Kcal)*	*% of malnourished children*	*Number of malnourished children (million)*
1990	2,332	63	70.86
2020:			
Baseline	2,692	45.49	47.73
Low population growth	2,814	41.53	39.87
Low investment slow growth	2,490	56.31	59.08
High investment rapid growth	2,886	35.71	37.47
Trade liberalization	2,711	43.91	46.07

Source: IFPRI, IMPACT simulation results Rosegrant et al 1995.

This improvement in the state of food security is likely to happen because, AOA under WTO does not constrain domestic policies that genuinely address poverty and food security, such as programs aimed at poor producers and consumers, stock for food security, and domestic food aids for population in need.

Putting Globalization to Work for Poor:

Trade liberalization, opening up economies in both developed and developing countries, more integrated international capital markets, and a free flow of labor, information, and technology are all parts of trend toward increasing globalization that is likely to continue and may even accelerate (Andersen, 2000). The role of the market becomes a paramount consideration. Agricultural and rural development become essential for generating broad based economic growth. Under the new market based and trade driven system, economic growth and national competitiveness are dependent on the development of a dynamic agricultural sector. Countries like Chile, Malaysia, and Thailand have grown and prospered by investing in their agriculture sectors (Bathrick, 1998). In India "given its sheer size and inherent characteristics, a dynamic agriculture sector becomes as essential element for broad-based economic growth" (Pandya-Lorch, 1994), while also enhancing the environment and creating a stable society. Agriculture requires a vision that transcends traditional sector approaches based on production. A pervasive import substitution legacy needs to be overcome to optimize response to the new economic order. Globalization calls for creation of the capacity to strategically advance and promote national comparative advantages and competitiveness (IFPRI, 2002).

To nurture the new agricultural system, the public and private system will need to develop institutional capacities and technologies. Government will have to reformulate attitudes; articulate national level comparative advantages, and define and develop operational roles and political support for cooperation among the producers, agribusiness, investment, NGOs, universities, and international research communities.

If India aggressively take the initiative and make major internal structural reforms-providing capable small and medium sized farmers and agribusinesses with essential skills, tools, and infrastructure, and facilitating private investment they will be better suited to meet unprecedented challenges and achieve more sustainable growth in political, economic, and environmental terms. Conversely, if structural reforms are not made, stagnation will occur.

Chapter 8

Agricultural Biotechnology and Food Security

Linkage Between Biotechnology and Food Security:

The term Green Revolution was coined in 1968 by Dr. William S. Gaud, Director of the US Agency for International development (USAID) when India achieved production of 17 million tons of wheat with the help of high yielding varieties of wheat, which had been introduced for the first time in Mexico. The so-called Green Revolution has had great effects on different segments of population of India, and has contributed to the great extent to the national food security through increased food supply and reduced food prices (See Kumar, 1998). But population of India is still increasing at a fast pace. Beside population increase, improved purchasing power among the poor will enhance the demand for food. In contrast, per capita availability of arable land is shrinking. Water use efficiency is still on the whole low and water disputes are growing. In addition to the gradual decline in per capita availability of land and water, various forms of biotic and abiotic stresses are spreading. There is still a widespread mismatch between production and postharvest technologies. In perishable commodities like fruits, vegetables, flowers, meat and other animal products, this mismatch is often severe, affecting the interests of both producers and consumers. This is why foreign experts frequently refer to the setting in of a fatigue of the Green Revolution (Swaminathan 1996). Lester Brown and Hal kane (1995) in their book full house 1995 predict that at the current rate of population growth and environmental degradation coupled with an improvement in the consumption capacity of the poor, India will have to import over 40 million tons of food grain by the year 2030. This is four times the quantity India imported in 1966, i.e., before the onset of the Green Revolution.

Agricultural biotechnology will contribute to poverty reduction and food security if scientists can develop technologies to increase quality and yields of food crops, and the technologies are adopted by small farmers. For this to happen, biotechnology R&D will have to meet four conditions:

(i) It must address both the problems of small farmers in rainfed areas where most of the poor live, and those of small farmers in irrigated areas, which provide the bulk of food grain supply in India.

(ii) It must focus on crops, livestock, and fish commonly grown by small farmers. Major crops are rice, tropical maize, wheat, sorghum, millet, banana, cassava, groundnut, oilseed, potato, and sweet potato. Biotechnology R&D should also focus on high value cash crops (e.g., cotton, soybean, and vegetables) that can increase the incomes of small farmers through crop diversification. The prospect for improving these crops is bright due to the large demand for them in urban areas and in international markets. Fish and livestock (cattle, sheep, goats, pigs, and chickens) are also important.

(iii) The technology to be developed and delivered to small farmers must be simple, low cost, and carry little or no risks to human health and the environment. As in the case of the Green Revolution, the most effective strategy to increase food production is through improved seeds that possess high yield potential, fertilizer responsiveness, resistance to pests and diseases, good agronomic characteristics, and good nutritional quality.

(iv) Biotechnology development should be accompanied by favorable policy environment; good governance; investments in rural Infrastructure; Agricultural credit and extension and marketing

Why Invest in Agricultural Biotechnology?

In much of India Yields of major food grains are stagnant or declining in the face of population increases. Pests and diseases cause substantial preharvest and postharvest losses of crops, livestock, and fish. Solutions to many of these problems may lie in the various applications of modern biotechnology.

The use of molecular markers to tag specific traits is accelerating the breeding of new varieties of plants and animals. New understanding of plant and animal genes through genomic may offer ways of increasing crop yields.

These new developments when used in conjunction with developments in the physical and social sciences, offer more sustainable means for obtaining necessary productivity increases that are less dependent on environmentally damaging inputs of chemical fertilizers and pesticides.

Given appropriate policies and necessary human and financial resources, modern biotechnology could make an extremely important contribution to future agricultural growth.

During the next 30 years, India will need a Second Green Revolution, often called Biorevolution or Doubly Green Revolution. Conway (1997) pointed out that the next technology-driven revolution must be doubly green it must increase food production at a faster rate than in recent years without significantly damaging the environment. It must also increase incomes and increase access to food by the poor. The differences between the Green Revolution and Biorevolution are described in box 1 compared to the Green Revolution of the 1970s; the following features will characterize Biorevolution:

i. Potentially many crops (particularly high value and specialty crops) will be affected as well as livestock and aquaculture.

ii. Potentially all areas, both irrigated, and rain fed will benefit from biotechnology R & D.

iii. Technology development and dissemination will be substantially involving private sector with the public sector playing the rule of facilitator and regulator.

iv. Many processes and products will be patentable and protectable.

v. Capital costs of research will be high.

vi. Molecular and cell biology will be required in addition to expertise in conventional plant breeding and other agricultural sciences.

Box 1: Characteristics of the Green Revolution and Biorevolution.

Characteristics	Green Revolution	Biorevolution
Crops affected	Mainly wheat and rice	Potentially all crops including cereals, vegetables, fruits, export commodities and specialty crops
Other products affected	None	Animal and fish products, processed products
Area affected	Irrigated and other favorable areas	Potentially all countries and all areas, including marginal lands
Technology development and dissemination	Largely public and quasi public sector	Substantial private sector involvement
Proprietary Considerations	Patents and plant variety protection not important	Many processes and products patentable and protectable
Capital costs of research	Relatively low	Relatively High
Research skill required	Conventional plant breeding and other agricultural sciences	Molecular and cell biology expertise plus conventional plant breeding skills and expertise in other agricultural sciences
Crops displaced	None, but traditional varieties and land races replaced by high yielding varieties	None, but traditional varieties and land races replaced by high yielding varieties
Access to information	Relatively easy	Restricted due to IPR

Source: ADB, 2000.

Past Achievements and Future Potential of Plant Breeding, Including Biotechnology, for Increasing Productivity of Major Staple Foods:

It is widely recognized in the international development community that using conventional technology alone will not result in the doubling or tripling of food production in the future. A combination of conventional and biotechnology applications has the potential to achieve global food security. Acknowledging that past experience is often the best guide for future, it is useful to review past achievements to increase crop productivity through plant breeding in the context of a seamless web that can provide continuity for combination of both conventional and biotechnology application to achieve food security. Achievements in conventional plant breeding in the two most important food crops in the world and India (Rice and Wheat) are reviewed, in conjunction with a discussion of potential benefits that future conventional and biotechnology applications offer. The review is appropriate from food security stand points as wheat is grown on more land than any other crop (about 225 million hectares), followed by rice (150 million hectares). In terms of usage as food, 85% of rice is used directly for human consumption compared with 60% of wheat (James, 2000).

The area planted to improved varieties of wheat in all Least Developing Countries (LDCs) on all continents (Byerlee 1994) increased steadily from 20 % in 1970 to 59% in 1983, to 78% in 1994 (Pingali and Rajaranm, 1998). Adoption rates where highest in Asia, increasing from 42% in 1970 to 91% in 1994. Adoption rates for improved rice varieties in all Least Developed Countries increased from 30% in 1970 to 74% in 1990 (Byerlee, 1994).

The high rates of adoption reflect the multiple benefits that the improved varieties offer farmers. For Example, in India index number of yield of Rice and Wheat, between periods of 1970-71 to 2000-2001 increased from 90.2 and 82.4 to 154.2 and 172.9 respectively (Table 1).

Table 1: Index Numbers of Yield of Wheat and Rice in India, 1970-71 to 2000-01.

Crop	*1970-71*	*1980-81*	*1990-91*	*2000-01*
Rice	90.2	107.7	140.2	154.2
Wheat	82.4	102.8	143.8	172.9

Source: Economic Survey 2001-02.

The annual genetic gains in cereal productivity is currently 1%, or less per year. Although this falls short of the increase required for meeting demand over the next 25 years, increasing annual genetic gains and applying biotechnology to shift the frontiers of yield potential offer the best probability of success. Given the performance of plant breeding over the last 30 years and promise that biotechnology offers, there is reason to be cautiously optimistic that cereal demands in 2020 be met (James, 2000).

Definition, History, and Scope of Biotechnology:

For approximately 10000 years human being have modified the traits of plants and animals through the process of artificial selection. As many previously wild species were domesticated to suit the needs and preferences of human beings, the performance and genetic architecture of these species were irrevocably changed. Indeed, most of our domesticated food and fiber species have been altered to such an extent that they are no longer capable of surviving in the wild. Instead they prosper only when nurtured and cultivated by human beings.

Over the centuries of crop cultivation and domestication of animals, the proccss of artificial (human) selection and selective breeding has created a diversity of food crops and animals with a wide variety of traits. For example, kale, cabbage, cauli-flower, broccoli and Brussels sprouts are all vegetable varieties derived from a single species (Bailey and Bailey 1976). Hybridization (the process of breeding genetically different parents with contrasting characteristics to produce a hybrid offspring with the useful characteristics of both parents) has resulted in higher yields and more disease resistant crops. For example, improved varieties of rice with significantly higher yields than traditional varieties have helped meet the developing world's food needs.

Karl Ereky, a Hungarian engineer, to describe the large-scale production of pigs that were fed sugar beets, first coined the term "biotechnology" in 1917(PEW Initiative for Food and Biotechnology, 2001). According to the1947 edition of Oxford English Dictionary; it referred "to the branch of technology concerned with the development and exploitation of machines in relation to the various physiological, psychological, and technological requirements of human being". It was observed that working conditions, lifestyle, and the entire web of human relations were affected by factory work and by interaction with the mechanized world. Thus, biotechnology originally referred to the study of how industrial society affected human beings.

However, The term evolve into its contemporary meaning only in the last 25 years, and it is interesting to note that human have assumed a very different role in the new scenario. The second definition of biotechnology, which appeared between 1972 and 1974, referred to "the branch of technology concerned with the genetic modification of living things to suit human needs and preferences. In this context, human being here become subjects rather than objects. Yet, according to this definition, humans have practiced plant biotechnology for about 10000 years, or as long as they have practiced agriculture.

Biotechnology, broadly defined, includes any technique that uses living organisms, or parts of such organisms, to make or modify products, to improve plants or animals, or to develop microorganisms for specific use. It ranges from traditional biotechnology to the most advanced modern biotechnology. Biotechnology is not a separate science but rather a mix of disciplines (genetics, molecular biology, biochemistry, embryology, and cell biology) converted into productive processes by linking them with such practical disciplines as chemical engineering, information technology, and robotics. Modern biotechnology should be seen as an integration of new techniques with the well-established approaches of traditional biotechnology such as plant and animal breeding, food production, fermentation products and processes, and production of pharmaceuticals and fertilizers (Doyle and Persley 1996).

The key components of modern biotechnology are listed below.

i) Genomics: The molecular characterization of all genes in a species.

ii) Bioinformatics: The assembly of data from genomic analysis into accessible forms, involving the application of information technology to analyze and manage large data sets resulting from gene sequencing or related techniques.

iii) Transformation: The introduction of one or more genes conferring potentially useful traits into plants, livestock, fish and tree species.

iv) Genetically improved organism.

v) Genetically modified organism (GMO).

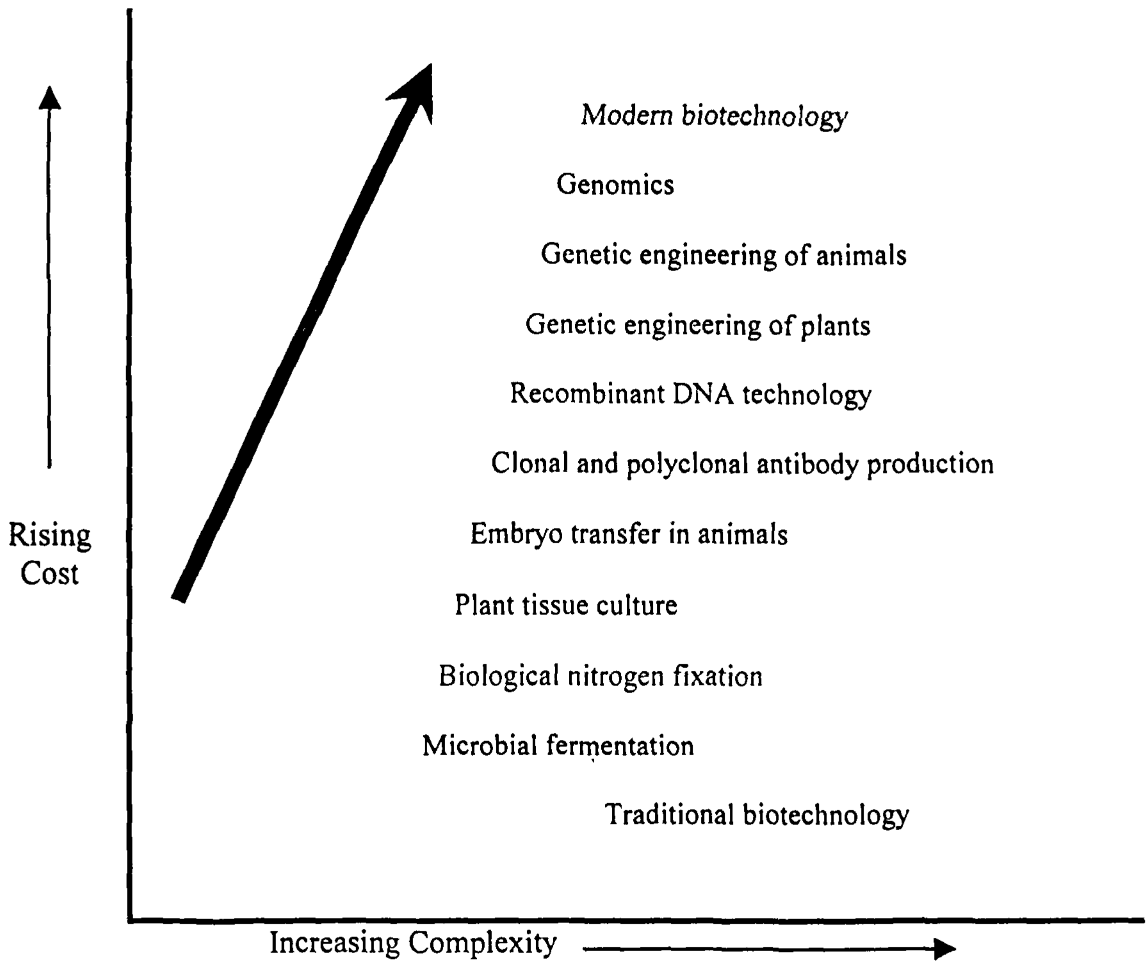
vi) Living modified organism (LMO).

vii) Molecular breeding: Identification and evaluation of useful traits in breeding programs by the use of marker-assisted selection (MAS);

viii) Diagnostics: The use of molecular characterization to provide more accurate and quicker identification of pathogens; and

ix) Vaccine technology: The use of modern immunology to develop recombinant deoxyribonucleic acid (rDNA) vaccines for improved control of livestock and fish diseases (Doyle and Persley 1999).

Figure 1: Gradient of Biotechnology



Source: Persley (1990) and Doyle and Persley (1996)

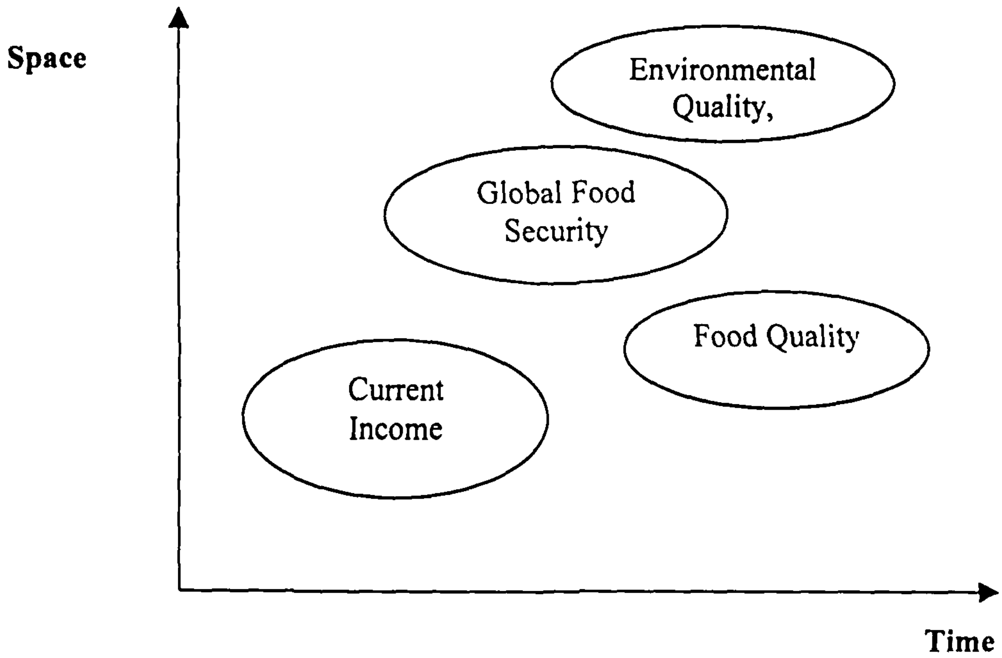
Today, the term biotechnology is largely associated with genetic manipulation at DNA level. However, it is important to note that not all biotechnology involves genetic engineering. Biotechnology in a broad sense is technique that uses living organisms or parts thereof to make or modify a product, improve plants or animals, or develop microorganism for specific uses.

Poor Farmers Small Holders and Biotechnology:

The successful employment of biotechnology by resource poor farmers depends crucially on the delivery of information and the performance of seed systems. Biotechnology has the potential of improving productivity and welfare for a wide range of farmers, but if small holders are to be targeted then attention must be directed to a number of structural deficiencies. Many of these deficiencies are related to information. Farmers' observation and experimentation have been responsible for the widespread diffusion of many new varieties. But farmers' understanding of new technology, and their ability to distinguish among the option, is often inadequate.

From the farmer's perspective, various technologies have the potential to reduce the use of inputs (such as pesticides), improve the quality and quantity of output, and thus increase income. If the on-farm benefits of such technologies are perceived to outweigh the costs of adoption, farmers have an incentive to use them (Wiebe, 2001). These technologies may also generate impacts off the farm and into the future (Figure, 2).

Figure 2: Dimensions of Biotechnology Impacts.



Source: Wiebe, 2001.

These include impacts on consumption, income, the environment, and food quality (including human health).

Information can be provided by extension services and by effective markets. The area in which green revolution were successful are not only distinguished by favorable growing conditions but also by adequate markets that are able to deliver the necessary inputs and purchased the increased production. Most small holders are currently not well served by seed markets; there are inadequate incentives for seed enterprise and local input marketing is often deficient. Yet most biotechnology will have to be delivered through private input systems. Without policies that support the development of strong and equitable local input markets, biotechnology is unlikely to reach many small holders.

If resource poor farmers are to participate in commercial input markets, they need to know how to voice their opinion and to pursue complaints. Better consumer protection and education programs are required to support farmers who will become increasingly dependent on private input markets. In addition, if resource poor farmers are a target for public biotechnology research, these farmers require increased representation in the decision making of public research institutes. Public research institutes bear a significant responsibility for addressing crops and production problems that are high priorities for small holders. They also are responsible for ensuring that farmers have access to sufficient information to allow them understand, test and evaluate biotechnology innovation.

IMPORTANCE OF AGRICULTURAL BIOTECHNOLOGY, BENEFITS AND RISKS OF GENE REVOLUTION

Modern biotechnology will not solve all the problems of food insecurity and poverty. But it could provide a key component to solution if given a chance (Gabrielle J. Persley and John J. Doyle, 2001).

Potential Benefits of Gene Revolution:

The benefits derived from GM varieties include the reduced use of insecticides and herbicides. Thus reducing soil and groundwater pollution, and reduced tillage that results in topsoil loss.

Many transgenic technologies in crops are designed to reduce yield losses from pests. These are generally the ones that code for pesticides such as Bacillus thuringienus (Bt) crops (corn, cotton, and potatoes). These crops can be thought of as pesticide-inherent crops. The pesticide kills pests that eat the plant, thus providing an effective and virtually complete pest control mechanism, at least in the short run. If these particular pests are present but are not in sufficient numbers to significantly affect yield, or if the pests affect yield but are cheap to control by other means, then the producer of pesticide-inherent crop may not experience a net benefit. If the pests are prevalent to an economically damaging extent in the area, however, then this complete control can result in significant yield increases.

There are also three major indirect economic benefits resulted from adoption of genetically modified crops. First, as farmers widely adopt GM crops the demand for conventional inputs specially pesticides and herbicides may decrease, which may in turn reduce prices of the non-transgenic systems (Gianeni and Carpenter, 2000). In this way all farmers, including non-adopter of transgenic varieties will benefit from reduced input prices. Second, field operations are saved with many of the transgenic crops; releasing resources for other crops at crucial time during the growing season, allowing farmers to better manage those crops. Farmers may also benefit from increased flexibility. As many chemical alternatives to the herbicide-tolerant crops present carry over problems so that farmers cannot plant certain crops in the next growing season. Herbicide-tolerant crops, used in conjunction with short-lived herbicides, eliminate this constraint in many cases. Farmers may also be able to strip crop or practice conservation tillage more easily with transgenic crops (Fernandez-Cornejo et al 1999).

Many studies show that pesticide inherent crops reduce the number of sprays required to control pests. If reduce pest control cost outweigh the additional cost of the seed, then farmers gain. Herbicide tolerant crops also can significantly reduce weed control costs. RR cotton is a good example. Before the introducing of this herbicide tolerant crop, there was no cotton herbicide that could be spray over the top of the cotton crop to control weeds (Carpenter and Gianeni, 2001). Now post emergence, over the top sprays are substituted for more expensive pre plant incorporated application of herbicides and mechanical cultivation to control weeds. Also, fewer weed control field operations may be needed which can result in significant savings (Marra et al, 2002). To cite an instance cotton occupies only 5 percent of India's land but cotton farmers roughly buy 50 percent of pesticides used in India alone at a jolting cost of RS 16 billion annually and immeasurable impacts on environment and human health. Use of Genetically Modified crops is also important from the point of view of income generation. The increase in the cotton yield as a result of use of Genetically Modified cotton seeds alone is expected to increase income of cotton farmers in India by $ 5 billion or RS 20,000 crore (Business Standard, 2001).

Yield can be raised substantially with the help of agricultural biotechnology for example "Cornell University researchers have added genes from two wild rice relatives to the best Chinese rice hybrids and are getting 20% to 40% higher yields" (Wilson, 1999).

Agricultural biotechnology, which is scale neutral, can help Indian farmers to produce more from their diminishing resources. It can help them by using for instance, new crop varieties that are drought tolerant, resistant to insect and weeds and capture nitrogen from the air and able to grow in the stress condition such as salinity and alkalinity and reduce their dependence on chemical inputs. "GM crops can also make the food farmers produce more nutritious by increasing Vitamin A, iron and other nutrients in the edible portion of plant" (Andersen, 1999). Furthermore through increase in productivity of current agricultural land, biotechnology can serve to protect wild lands that will be metamorphosed to farmland if the system were less productive (See Swaminathan 2000, Trewavas 2001). In this way it can help to protect biodiversity.

In India, salt build up is resulting in seven million hectares of prime agricultural land losing productivity. Along with crops engineered to thrive in saline environments that are currently unusable for agriculture, transgenic plants tolerate to acidic soil, and those resistant to drought, will contribute to future food security and prevent further deforestation by preventing the loss of arable land through salinity and acidity.

The ICAR calculated that, by using Integrated Pest Management methods with one or two spray the Bt cotton hybrids could save Rs. 1500 per hectare on chemical pesticides and provide additional return through higher yield of Rs. 7000 to 8000 per hectare. This corresponds with Chinese experience, where Bt cotton has grown rapidly since its introduction in 1997. According to a paper in January 2000 issue of science, Bt cotton farmers reduced pesticide use by an average of 13 spray per season. The saving in pesticide and spraying costs lowered their production costs by 28 percent (Hindu Survey of Indian Agriculture, 2002).

Work in India has shown that genetic modification can do immense good in agriculture and food security (Swaminathan, 2001). Food security is an area in which biotechnology offers major inputs for healthier and more nutritious food. With the advent of gene transfer technology there is hope for achieving higher productivity and better quality, including improved nutrition and storage of food.

In fact, the most compelling case for biotechnology is its potential contribution to food security. But it is critical that combined strategy of conventional and biotechnology applications be adopted as the technology module of a global food security initiative. Implementation of such an approach will allow society to continue to benefit from the vital contribution that plant breeding offers the nation on account of:

- Continued annual increments in productivity achieved through genetic gains, which will also generate healthier and more nutritious food/feed products.
- A land-saving practice which will allow production to be limited to the current cultivated land where sustainable agriculture can be practiced while saving fragile ecosystems and environments, the in situ centers of biodiversity, wildlife, and forests for future generations.
- More efficient use of external inputs substitute and develops alternatives to conventional pesticides, which represent a potential hazard for producers, consumers, and environment.
- Increased stability of yield. Biotechnology offers the best option for reducing the variability in yield due to both a biotic and biotic stresses, especially a complex trait such as drought, which is a pervasive constraint that applies to at least one-third of the 1.5 billion hectares of global cultivable land.

Macer 1997 summarized some of the potential benefits of agricultural biotechnology and genetic engineering in table form (Box 2).

Box 2: Potential Benefits from Plant Genetic Engineering.

Benefit	*Example*
Increasing crop productivity	• Improving growth rate • Altering ratio of Usable product (e.g., increasing proportion of seed in rice)
Increasing crop quality	• Improving nutritional quality (e.g. specific vitamin contents, type and content of fiber, fat components, amino acids). • Removing food contaminants and toxins (e.g., aflatoxins). • Improving storage properties (e.g., fresh vegetables and fruits).
Environmental adaptation	• Making crops plants better adapted to changing environments.
Broadening stress tolerance	• Making plant more resistant to drought, flooding, salinity, heavy metals pollution.
Increasing disease and pest resistance	• Selecting resistant varieties (e.g., using molecular techniques to insert antiviral or antibacterial genes from other species). • Hybridizing crops with wild relatives (e.g., use of cellular methods for rapid screening for desired phenotypes).
Agrochemical reduction	Breeding crop varieties resistant to specific herbicides (e.g. glyophosate resistant Soybean, through insertion of a bacterial gene that reduces sensitivity to herbicide).
Use of new raw materials	• Production of single cell (e.g., growing bacteria on methanol for animal feed, growing mycoprotein from fungi and wastes from pulp and paper industry).

Source: Macer, 1997

Hypothetical Risks:

Genetically improved products are subjected to radical testing, while conventional varieties have never been subject to any such regulation for food safety and environmental impact. Traditional methods of developing crops involving wild crosses with weedy relatives of crop plants. Hundreds of unknown genes, of whose traits we have little knowledge, are introduced into these food crops through these conventional plant-breeding methods. Many characteristics such as disease and pest resistance have been routinely introduced into crop plants from their weedy and distant relatives over hundreds of years. These have posed no serious threat to the environment in terms of crop invasiveness, gene flow to weeds or bio-diversity. Yet some of these fears are invoked for genetically improved crops which possess similar traits, but are developed through a rapid genetic modification processes.

Thousands of new plants have been introduced into India since Vasco De Gama, and no one now questions the invaluable impact these exotic introduction have made on Indian agriculture, food habits and the economy. These include chili, wheat, potato, cabbage, groundnut, cowpea, apple, grape, eucalyptus, rose and countless ornamentals. Genetically improved crops, on the other hand, do not involve any such whole sale introduction of thousands of new genes through new plants, only alteration of just one or two gene with known traits in the already popular Indian crops varieties. There is therefore, a far miniscule risks posed by genetically improved crops. The enormous potential benefits from these crops therefore, far outweigh any hypothetical risks posed to their use.

Thousands of field tests conducted so far on various genetically improved crops with more than one hundred new traits, or their commercial planting on 52 million hectares world wide have failed to provide any serious evidence of food safety or environmental concern. Gene altered corn and soybean products including baby food, have now found their way into nearly 4000 food products in American supermarkets. Yet not a single issue of food safety has been reported. It should be pointed out that American standards of food safety are the highest in the world. The regulatory agency, the Food and Drugs Administration, has one of the world's strictest standards and thus enjoy considerable public trust.

Advances in agricultural biotechnology have created opportunities for efficient crop improvement. However this process necessitates caution to prevent unforeseen problems associated with the adoption of new crop varieties. Biosafety issues need to be dealt with carefully. Comprehensive testing followed by open discussion among the different stakeholders would help create public confidence.

Here, it would be proper to mention that some people in the developed countries fundamentally distrust genetically modified foods. But in some cases, they want to make choices for others, never mind what benefits GM foods may offer to poor people in developing countries. Thus, the violent objections by some cannot be used as a basis for objection to this technology in India. It is important to note that those countries are not only self-sufficient in food, but have a surplus and can therefore spend time to deliberate.

Global Area of Transgenic Crops:

The estimated global area of transgenic crops for 2001 is 52.6 million hectares or 130.0 million acres (Table 2). It is note worthy that 2001 is the first year when the global area of transgenic corps has exceeded the important historical milestone of 50 million hectares to put this global area of transgenic crops into contexts 52.6 million hectares is equivalent to more than 5% of total land area of China (956 million hectares) or the US (981 million hectares) and more than twice the land are of the United Kingdom (24.4 million hectares). The global increase in area of transgenic corps between 2000 and 2001 is 19%, equivalent to 8.4 million hectares or 20.8 million acres. This increase of 8.4 million hectares between 200 and 2001 is almost twice the corresponding increase of 4.3 million hectares between 1999 and 2000, which was equivalent to an 11% growth.

Table 2: Global Area of Transgenic Crops, 1996 to 2001.

	Hectares (million)	*Acres (million)*
1996	1.7	4.3
1997	1.0	27.5
1998	27.8	69.5
1999	39.9	98.6
2000	44.2	109.2
2001	52.6	130.0

Source: ISAAA, 2001.

During the six-year period 1996 to 2001, the global area of transgenic corps increased by more than 30-fold, from 1.7 million hectares in 1996 to 52.6 million hectares in 2001.

This high rate of adoption reflects the growing acceptance of transgenic corps by farmers using GM technology in both industrial and developing countries. During the six-year period 1996-2001, the number of countries growing transgenic corps more than doubled, increasing from 6 in 1996 to 9 in 1998, to 12 countries in 1999 and 13 in 2000 and 2001.

Table 3 shows the relative hectarage of transgenic corps in industrial and developing countries during the period 1998 to 2001. It clearly illustrates that whereas the substantial share of GM crops have been grown in industrial countries, the proportion of transgenic corps grown in developing countries has increased consistently from 16% in 1998, to 18% in 1999, 24% in 2000 and 26% in 2001. Thus, in 2001 more than one quarter (Table 3) of the transgenic corps area of 52.6 million hectares, equivalent to 13.5 million hectares, may grown in developing countries where growth continued to be strong between 2000-2001. Whereas the absolute growth in GM crop area between 2000 and 2001 was twice as high in industrial countries (5.6 million hectares) compared with developing countries (2.8 million hectares), the percentage growth was higher in the developing counties of the south (26%) than in the industrial countries of the North (17%).

Table 3: Global Area of Transgenic Crops in 2000 and 2001. Industrial and Developing Countries (million hectares).

	1998	*%*	*1999*	*%*	*2000*	*%*	*2001*	*%*	*+/-*	*%*
Industrial countries	23.4	84	32.8	82	33.5	76	39.1	74	+5.6	+17
Developing countries	3.2	16	7.1	18	10.7	24	13.5	26	+28	+26
Total					44.2	100	52.6	100	+8.4	+19

Source: ISAAA, 2001.

Distribution of Transgenic Cops by Country:

In 2001, four countries grew 99% of the global transgenic crops area (Table 4), and all four countries reported growth of GM crops between 2000 and 2001. It is noteworthy that the top four countries include two industrial countries, USA and Canada, and two developing countries, Argentina and China. Consistent with the pattern since 1996, the USA grew the largest transgenic crops hectarage (68%) in 2001. The USA grew 35.7 million hectares, followed by Argentina with 11.8 million hectares (22%), Canada 3.2 million hectares (6%) and China 1.5 million hectares (3%); China had the highest percentage year-on-year growth by tripling its GM crops area of Bt cotton between 2000 and 2001. Year-on-year growth was the same (18% for the USA and Argentina and lower for Canada (6%). In 2001, transgenic crops hectarage also increased in South Africa and Australia where the growth rates were 33% and 37% respectively.

The 13 countries that grew transgenic crops in 2001 are listed in descending order of their transgenic crop areas (Table 4). There are 7 industrial countries and 6 developing countries. In 2001, transgenic crops were grown commercially in all six continents of the world. North America, Latin America, Asia, Oceania, Europe and Africa of the top four countries that grew 99% of the global transgenic crop area, the USA grew 68%, Argentina 22%, Canada 6% and China 3%. The other 1% was grown the remaining 9 countries, with South Africa and Australia being the only countries in that group growing more than 100,000 hectares or a quarter million acres of transgenic crops.

In the USA there was an estimated net gain of 5.4 million hectares of transgenic crops in

2001. This came about as a result of significant increase in the area o f transgenic soybean and cotton, a modest increase in Canola, and a small decrease in the area of transgenic corn. In Argentina, a gain of 1.8 million hectares was reported for 2001 because of significant growth in transgenic soybean and a modest increase in Corn.

For Canada, a net gain of 0.2 million hectares was estimated with gains in both GM corn and soybean and with a slight decrease in GM canola associated with the general decrease of 856,000 hectares in the national area planted to canola in 2001 compared with 2000. For China, the area planted to Bt cotton increased by significant 1.0 million hectares from 0.5 million hectares in 2000 to 1.5 million hectares in 2001.

A *significant increase of* Bt corn was reported for South Africa, where the combined area of transgenic corn, cotton and soybean is expects to be approximately 225,000 hectares. In Australia, over 200,000 hectares of transgenic cotton was planted in 2001 compared with 150,000 hectares in 2000, with Mexico reporting a modest area of transgenic cotton and soybean. The countries growing transgenic crops in 2001 include two Eastern European countries, Romania growing herbicide tolerant soybean, and Bulgaria growing herbicide tolerant corn. The two European Union Countries (Spain and Germany) which grew small areas of Bt corn in 2000, continued to grow Bt corn in 2001 Spain grew about 12,000 hectares and Germany less than a hundred hectares in 2001. France, which grew a token area of Bt corn in 2000, did not report any Bt corn for 2001. One new country, Indonesia, reported the commercialization of transgenic crops for the first time in 2001, growing a small area, 4,000 hectares, of Bt cotton. The country portfolio of deployed GM crops continued to diversify in 2001 with several crop/trait introductions reported for the first time. These included: herbicide tolerant corn in Argentina; herbicide tolerant cotton as well the stacked Bt/herbicide tolerant cotton in Australia; herbicide tolerant soybean, Bt white corn , herbicide tolerant cotton in South Africa, and Bt cotton in Indonesia (James, 2001).

Table 4: Global Area of Transgenic Crops in 2000 and 2001: by Country (million hectares).

	2000	*%*	*2001*	*%*	*+/-*	*%*
USA	30.3	68	35.5	68	+5.4	+18
Argentina	10.0	23	11.8	22	+1.8	+18
Canada	3.0	7	3.2	6	+0.2	+6
China	0.5	1	1.5	3	+1.0	+200
South Africa	0.2	<1	0.2	<1	<0.1	+33
Australia	0.2	<1	0.2	<1	<0.1	+37
Mexico	<0.1	<1	<0.1	<1	<0.1	-
Bulgaria	<0.1	<1	<0.1	<1	<0.1	-
Uruguay	< 0.1	<1	<0.1	<1	<0.1	-
Romania	< 0.1	<1	<0.1	<1	<0.1	-
Spain	< 0.1	<1	<0.1	<1	<0.1	-
Indonesia	-	-	<0.1	<1	<0.1	-
Germany	< 0.1	<1	<0.1	<1	<0.1	-
France	< 0.1	<1	-	-	-	-
Total	44.2	100	52.6	100	+8.4	+19

Source: ISAAA, 2001

Distribution of Transgenic Crops, by Crop:

The distribution of the global transgenic crop area for the four major crops is illustrated in Table 5. It shows the dominance of transgenic soybean occupying 63% of the global area of transgenic crops in 2001; the entire transgenic soybean is herbicide tolerant. Globally, transgenic soybean occupied 33.3 million hectares in 2001, with transgenic corn in second place at 9.8 million hectares, transgenic cotton third place at 6.8 million hectares, and canola at 2.8 million hectares.

Table 5: Global Area of Transgenic Crops in 2000 and 2002: by Crop (million of hectares).

Crop	*2000*	*%*	*2001*	*%*	*+/-*	*%*
Soybean	25.8	548	33.3	63	+7.5	+29
Maize	10.3	23	9.8	19	-0.5	-5
Cotton	5.3	12	6.8	13	+1.5	+28
Canola	2.8	7	2.7	5	-0.1	-4
Potato	<0.1	<1	<0.1	<1	<0.1	-
Squash	<0.1	<1	<0.1	<1	(--)	--
Papaya	<0.1	<1	<0.1	<1	(--)	--
Total	44.2	100	52.6	100	+8.4	+19

Source: ISAAA, 2001

In 2001, the global hectarage of herbicide tolerant soybean is estimated to have increased by 7.5 million hectares, equivalent to a 29% increase. Gains of approximately 5.7 million hectares of transgenic soybean were reported for the USA in 2001 with 71% of the national soybean area of 30.1 million hectares planted to transgenics. Argentina reported a gain of 1.8 million hectares of GM soybean with adoption rates estimated at 78% of the 11.2 million hectares of soybean grown in 2001. Transgenic corn area in 2001 is estimated to have decreased globally by about 500,000 hectares with all the reduction in the USA. The small decrease of 100,000 hectares in area planted globally with transgenic canola in 2001 all occurred in Canada and was associated with the general decrease of 85,6000 hectares in the national area planted to canola in Canada in 2001 compared with 2000; the decrease in canola area is attributed to low prices. However, the percentage of the canola crop in Canada planted to transgenics increased from 55% in 2000 to 61% in 2001. The decrease in Canada in 2001 was offset by a modest increase in transgenic canola in the USA, which increased by more than 10% in 2001.

The global area of transgenic cotton in 2001 is estimated to have increased by 1.5 million hectares, from 5.3 million hectares in 2000 to an estimated 6.8 million hectares in 2001. This is equivalent to a year-over-year increase of 28% in the global area of transgenic cotton. The most significant increase was reported for China which tripled its Bt cotton area from 0.5 million hectares in 2000 to 1.5 million hectares in 2001. in the USA the percentage of transgenic cotton increased from 72% in 2000 to 77% in 2001. Australia also increased its transgenic cotton area by 33% from 150,000 hectares to 200000 hectares with plantings at approximately the same levels in Mexico, Argentina and South Africa.

Distribution of Transgenic Crops, by Trait:

During the six-year period 1996 to 2001, herbicide tolerance has consistently been the dominant trait with insect resistance second. In 2001, herbicide tolerance, deployed in soybean, corn and cotton, occupied 77% of the 52.6 million hectares (Table 6), with 7.8 million hectares planted to Bt crops equivalent to 15%, and stacked genes for herbicide tolerance and insect resistance deployed in both cotton and corn occupying 8% of the global transgenic area in 2001. it is noteworthy that the area of herbicide tolerant crops has increased significantly by 24% or 7.9 million hectares between 2000 and 2001 (32.7 million hectares to 40.6 million hectares). Crops with stacked genes for herbicide tolerance and Bt also increased from 3.2 million hectares in 2000 to 4.2 million hectares in 2001, whereas the global area of insect resistant corps has decreased from 8.3 million hectares in 2000 to 7.8 million hectares in 2001.

Table 6: Global Area of Transgenic Crops in 2000 and 2001: By Trait (million hectares).

Trait	*2000*	%	*2001*	%	+/-	%
Herbicide tolerance	32.7	74	40.6	77	+7.9	+24
Insect resistance (Bt)	8.3	19	7.8	15	-0.5	-6
Bt/Herbicide tolerance	3.2	7	4.2	8	+1.0	+31
Virus resistance / other	<0.1	<1	<0.1	<1	<0.1	-
Global Total	44.2	100	52.6	100	+8.4	+19

Source: ISAAA, 2001.

FUTURE BIOTECHNOLOGY TRAITS; KEY TO FOOD SECURITY

I. Input Traits:

Transgenic crops that are currently commercialized incorporate the first generation of traits called "input traits" that confer agronomic advantages. There include the principal trait of herbicide tolerance, with insect resistance as a second category plus a few virus resistant products. The listing of input traits in Table 7 projects that herbicide tolerance will be extended to corps including rice, wheat, potato, fodder beet, sugar beet, sugar cane, alfalfa, tomato, lettuce, and sunflower. Similarly, insect resistant products will cover a much broader range of pests that cause economic loses on crops in different regions of the world. For example, the current range of Bt corn products are principally designed to control the European corn borer, but also provides some control of the other insect parts of corn such as earworm. The next range of insect resistant for corn will be specially tailored to control specific pests in particular regions. Accordingly, Bt and other gene products will be tailored to control fall armyworm in the USA and Latin America where the pest is particularly important. Similarly, specific products will be available for the Asiatic corn borer in Asia and the African borer in Africa. Products with more than one Bt genes increase the durability of Bt resistance and products with Bt and other mechanisms of resistance will provide further security and offer new possibilities for optimizing the durability of deployed genes. Genes that confer resistance to insects will be available to cover a broad range of crops including rice, soybean, sunflower, tomato, sugarcane, sweet potato, apple, and poplar. Many observers have been justifiably concerned that most, if not all, transgenic products commercialized to date have been developed to meet the demands of large farmers in industrial countries and not the small resource poor farmers in developing countries. It is therefore noteworthy that some of the new products that are likely to be available, such as insect resistant sweet potato and virus-resistant canola, are crops that are almost exclusively used by small resource-poor farmers in developing countries.

Virus resistances, which is particularly important for developing countries where seed certification schemes are not very effective, is likely to be available for a broader range of viruses, and for more corps. Virus-resistant products are likely to be deployed for CMV and TMV tomato, CMV in sweet pepper, barley yellow dwarf virus (BYDV) in wheat, possibly beet yellow virus and turnip yellow virus in canola/rapeseed will become available for the control of fungal pathogens. Gene discovery programs for pathogens such as phytophthora infestuamrs of potato have been conducted for several years but as yet no products have been commercialized. There is a possibility that in the near germ, genes may be available for the control of Fusarium diseases in corn and wheat that are associated with mycotoxins; black sigataka disease of bananas; and sclerotinia and verticillium diseases of sunflower. The xa21 gene bacterial blight of rice is also being tested in field trials and could be ready for deployment in the near term. Genes for delaying senescence (the stay green effect) also have significant potential for increasing productivity as a result of prolonging photosynthetic activity, and there is a candidate gene that may be available in rice. Finally, male sterility, restorer and other hybridization genes being used in canola have potential for many other crops including rice and maize in the near term and wheat in the midterm. Genes for aluminum tolerance have been identified for deployment in corps growing in acid soils but will probably not be available until the midterm.

Beyond the near term, preliminary findings look promising for several traits including drought resistance and genes that can increase the efficiency of fertilizer uptake, more specifically nitrogen. Fertilizer, particularly nitrogen played a critical role in both the wheat and rice green revolutions initiated in the 1960s undouBtedly the use of nitrogen will continue to play a key role in many applications of new technologies in the first decade of the new millennium as the longer term target of doubling food production by 2050 becomes an increasingly pressing need. Of the 130 million tons of fertilizer used annually on crops, 60% of the volume and 70% of the $50 billion cost is represented by nitrogen fertilizers (James, 1997). The challenge is to optimize the use of nitrogen fertilizers through developing crops varieties that are more responsive to nitrogen. A significant increase in the efficiency of nitrogen uptake would allow food production to be increased significantly with a minimal increase in nitrogen fertilizer use; this would coincidentally mitigate the environmental concern resulting from high nitrate levels in ground water in areas where very intensive agriculture is being practiced.

Collaborative research at the university of Florida and Monsanto led by Robert Schmidt at Florida has led to the isolation of a gene from the algae *Chlorella Sorokiniana* that may enable crops to use nitrogen more effectively, increasing yields by 29% (James, 2000).

II. Output Traits:

The output traits represent the second generation of traits for transgenic crops, conferring improved quality characteristics that will result in benefits to consumers, food processors, and producers. Unlike input traits, that have delivered multiple agronomic and productivity related gains to producers, the benefits of output traits will be evident to consumers. Benefits will include improved shelf life, and more nutritious, healthier and testier foods. Because these benefits will be evident to consumer, quality traits have the potential to particularly impact on public acceptance.

The first output/quality trait introduced into transgenic crops was the delayed ripening trait in Falvr Savr tomato. The delayed ripening altered shelf life genes have enormous potential for tropical fruits and vegetables in developing countries where post harvest losses are high because of high temperatures and humidity, inadequate transportation from farm to market, and lack of appropriate or refrigerated storage.

The quality traits that are likely to become available in the near term can be classified into five arbitrary categories. The high oleic soybean exemplifies the first category, featuring healthier and more nutritional food and feed products. The other products that fall into same category are include corn with high oleic oil, high lysine, high trytophen, low phytate, and high oil through traditional breeding stacked with various transgenic quality traits; soybean with high oleic oil improved proteins, high stearate oil, higher sucrose, low saturate oil, low linoleic oil, and low phytate, canola with high stearate oil, high oleic, low polyunsaturated oil and low phytate; sunflower with high oleic oil; and potatoes with high solids. The second category includes gene products includes gene products that are being developed as potential remedies for vitamin deficiencies. The most advanced product in this class results from the successful and well publicized research of Dr. Ingo Potrykus and Dr. Peter Beyer who identified genes that coded for higher levels of beta-carotene (precursor of vitamin A) and incorporated these in rice (Gunu 1999). Research is also under way on high beta-carotene canola and on genes encoding for vitamin E and preliminary work on vitamin C. The third category includes traits that enhance levels, of microelements and offer potential remedies for microelement deficiencies. Again, the work of Dr. Potrykus et al in enhancing iron level in rice is the most advanced, and offers a potential remedy for anaemia that is estimated to effect up to 3 billion people. The fourth category includes traits with improved chemical structure that result in better flavor, taste, or structure and /or enhance the quality of storage of food/feed products like starch or proteins for food, feed, or industrial processing, products in this category include corn with modified starch, potatoes with modified starch and improved storage quality, wheat with improved quality, and papaya with delayed ripening. The fifth and final category includes traits that improve fiber qualities, such as improved fiber quality in cotton.

Table 7: Listing of Selected Potential Transgenic Crops for Commercialization in the Near to Midterm, from 2000 Onwards.

Input traits	**Benefits**
Corn/Maize	
Rootworm resistance	Reduced lossed valued at >$1 billion/annum in USA alone
Fall armyworm resistance	Control of pest in USA and Latin America
Earworm resistance	Control of pest in USA and Latin America
Asiatic corn borer resistance	Control of pest in Asia
African stem borer resistance	Control of pest in Africa
Fungal resistance	Control of Fusarium head scab and mycotoxins
Cotton	
Second generation genes for bollworm resistance	Contributes to more durable deployment of genes for pest

Boll weevil resistance	Control of an important and prevalent cotton pest
Soybean	
Insect resistance	Pod borer and looper control
Stakced gene Bt/ Herbicide tolerance	Reduced yield losses to insect pests and weeds
Canola	
Hybridization genes	Improved hybridization technology
Virus resistance	Control of beet yellow virus and/or turnip yellow virus
Potatoes	
Herbicide tolerance	Improved weed control
Insect resistance	Control of Colorado beetle for varieties for E. Europe
Virus resistance	Control of multiple viruses
Fodder beet	
Herbicide tolerance	Improved weed control
Sugar beet	
Herbicide tolerance	Improved weed control
Rice	
Herbicide tolerance	Improved weed control
Bacterial disease resistance	Control of bacterial leaf blight
Insect resistance	Control of rice stem borer
Delayed senescence	Increased productivity
Wheat	
Fungal disease resistance	Reduced yield losses due to Fusarium and other diseases
Virus resistance	Control of barley yellow dwarf virus
Herbicide resistance	Improved weed control
Sunflower	

Insect resistance	Control of Lepidpoteran pests
Herbicide tolerance	Improved weed control
Fungal disease resistance	Control of Sclerotinia and Verticillium
Tomatoes	
Insect resistance	Reduced losses to looper, hornworm, and fruitworm
Virus resistance	Improved control of DMV virus disease
Virus resistance	Improved control of TMV virus disease
Herbicide tolerance	Improved weed control
Sugarcane	
Herbicide tolerance	Improved weed control
Insect resistance	Control of sugarcane borer
Sweet potato	
Insect resistance	Control of sweet potato weevil
Virus resistance	Control of feathery mottle virus
Bananas	
Disease resistance	Control of black sigatoka fungal disease
Cassava	
Virus resistance	Control of cassava mosaic virus
Alfalfa	
Herbicide tolerance	Improved weed control
Apple	
Insect resistance	Bt gene for control of insect pests
Lettuce	
Herbicide tolerance	Improved weed control
Poplar	

Insect resistance	Bt gene for control of insect pests
Corn/Maize	
High oleic oil	Healthier nutritional profile
Modified starch	Improved quality
High lysine	Feed with improved nutritional profile
High methionine	Feed with improved nutritional profile
High tryptophan	Feed with improved nutritional profile
High oil (normal) + other traits	Feed with improved nutritional profile
Low phytate	Reduces need for phosphate supplements
Soybean	
High oleic oil	Healthier and more nutritious food products
Improved proteins	Improved flavor and texture
High stearate	Healthier and more nutritious food products
Higher sucrose	Healthier and more nutritious food products
Low saturate oil	Healthier and more nutritious food products
Low linoleic oil	Healthier and more nutritious food products
Low phytate	Reduces need for phosphate supplements
Enhanced vitamin E	Remedy for vitamin E deficiency
Canola	
High stearate oil	Healthier food products
High oleic oil	More nutritious food ingredients
Low polyunsaturated oil	Healthier and more nutritious food products
High beta-carotene	Remedy for vitamin A deficiency
Potatoes	
Modified starch	Improved quality

Improved storage quality	Less postharvest losses
Higher solids	Lower water content and absorbs less oil in cooking
Sunflower	
High oleic oil	Healthier and more nutritious food products
Wheat	
Improved quality	Better health profile and processing qualities
Cotton	
Improved fiber quality	
Rice	
Modified starch	Improved quality
Enhanced vitamin A	Remedy for vitamin A deficiency – affects 400 million
Enhanced iron content	Remedy for anemia – afflicts 3 billion people
Papaya	
Delayed ripening	Reduces postharvest losses

Source: Clive James 1999

Indian Share in World Transgenic Crops:

Despite all positive impacts of agricultural biotechnology, which have been experienced during past decade by developed as well as developing countries, application of GM crops in India has been limited only to experimental farms.

The Indian government has made substantial investments in biotechnology research. (ADB, 2001). The first experiment on transgenic plants in the field was started in 1995 when *Brassica juncea* plants containing *Barnase*, *Barstar*, and *Bar* genes were planted at Gurgaon (Haryana) to assess the extent of pollen escape. Subsequently, several experiments have been started in the field in different locations using transgenic mustard, cotton, and tomato. Several Indian institutes and organizations claim that they have developed transgenic plants, which are ready for greenhouse/screenhouse/polyhouse evaluation, and some for field evaluation as well. Table 8 gives a summary of the major developments in transgenic plants in India.

Table 8: Transgenic Research in India.

Institute	Plants/crops used for transformation	Transgenes inserted	Aim of the project and progress made
Central Tobacco Research Institute, Rajahmundry	Tobacco	Bt toxin gene – CryIA(b) and CryIC	To generate plants resistant to H. armigera and S. litura. One round contained field trial completed. Further evaluation under progress.
Bose Institute, Calcutta	Rice	Bt toxin genes	To generate plants resistant to lepidopteran pests. Ready to undertake greenhouse testing.
Tamil Nadu Agricultural University, Coimbatore	Rice	Reporter genes like hph or gus	To study extent of transformation frequency.
University of Delhi, South Campus, New Delhi	Mustard/rapeseed	Bar, Barnase, Barstar	Plant transformations completed and ready for greenhouse experiments
	Rice	Selectable marker genes, e.g., hph resistance and gus	Gene regulation studies. Transformations completed.
National Botanical Research Institute, Lucknow	Cotton	Bt toxin gene	To generate plants resistant to lepidopteran pests. Laboratory transformations in progress.
Indian Agricultural Research Institute, substation at Shillong	Rice	Bt toxin gene	To impart resistance to lepidopteran pests. Transformations in progress.

Central Potato Research Institute, Shimla	Potato	Bt toxin gene	To generate plants resistant to lepidopteran pests. Ready to undertake greenhouse trials.
ProAgro–PGS India Ltd, New Delhi	Brassica (Mustard)	Barstar, Barnase, Bar	To develop better hybrid cultivars suitable for local conditions. Contained field trails in over 15 locations completed. Further contained open-field research trials in progress at many locations.
	Tomato	Cry1A(b)	To develop plants resistant to lepidopteran pests. Glasshouse experiments and one-season contained field experiment completed. Further experiments in progress.
	Brinjal	Cry1A(b)	To develop plants resistant to lepidopteran pests. Glasshouse experiments in progress.
	Cauliflower	Barnase, Barstar, Bar	To develop hybrid cultivars for local use. Glasshouse experiments in progress.
	Cauliflower	Cry1H/Cry9C	To develop resistance to pests. Glasshouse experiments in progress.
	Cabbage	Cry1H/Cry9C	To develop resistance to pests. Glasshouse experiments in progress.
Mahyco, Mumbai	Cotton	Cry1A(c)	To develop resistance to lepidopteran pests. Multicentric field trials in over 40 locations completed and further contained field trails in progress.
Rallis India Ltd, Bangalore	Chilli	Snowdrop (Galanthus nivalis) Lectin gene	Resistance against lepidopteran, coleopteran, and homopteran pests. Transformation experiments in progress.
	Bell pepper	Snowdrop (Galanthus nivalis) Lectin gene	Resistance against lepidopteran, coleopteran, and homopteran pests. Transformation experiments in progress.

	Tomato	Snowdrop (Galanthus nivalis) Lectin gene	Resistance against lepidopteran, coleopteran, and homopteran pests. Transformation experiments in progress.
Indian Agricultural Research Institute, New Delhi	Brinjal, Tomato, Cauliflower, Mustard/rapeseed	Bt toxin gene	To impart resistance to lepidopteran pests. Transformation completed, greenhouse trials completed, and one-season field evaluation completed for brinjal and tomato.
Jawaharlal Nehru University, New Delhi	Potato	Gene expressing for protein containing lysine obtained from Amaranthus plants	Transformation completed and transgenic potato under evaluation.

Source: http://www.teriin.org/gmp/status

However, it was only on March 26th 2002 that the union Government's Genetic Engineering Approval Committee (GEAC) cleared the release of India's first genetically engineered crop, cotton carrying a gene from the soil bacterium *Bacillus Thringinesis* (Bt). The Maharashtra Hybrid Seeds Company (Mahyco) has been permitted to release three hybrid cotton lines carrying Bt genes. A fourth transgenic variety better suited for cultivation in the Northern states is awaiting further field trials and will be released next year (Hindu survey of Indian agriculture,2002). Thus in the field of commercial planting of GM crops India is a newcomer. The cause of failure to expand area under GM crops in India lies on precautionary approach that has been adopted by Government of India in regards to the most of the important issues related to GM crops. This is as a result of the fact that critics of GM crops have been able to work within India's open and democratic political system to secure a far more cautious approach toward biotechnology.

POLICY CHOICES:

The role of government in diffusion of GM crops falls into five distinct areas including; Intellectual Property Rights, trade, food Safety, Biosafety, and Public research investment.

Intellectual Property Rights Policy:

During the Green Revolution of the 1960s and 1970s, government in developing world did not feel compelled to provide private companies or private plant breeders with exclusive intellectual property rights to the sale or use of new crop technologies. The new high-yielding crop varieties then being offered to the sale or use of developing-country farmers have been developed by breeders working for philanthropic or public research institutions. The new seeds were not developed and sold by private companies; instead they were given way through international assistance programs, distributed by non-profitable NGOs or sold at subsidized prices by government corporations.

So far in the GM crop revolution, it is private companies that have taken the lead. When public funding for international agricultural research faltered in the 1980s, the initiative in developing most new GM crop fell to private seed and biotechnology companies (James 2000; Enrique's and Goldberg 2000). These companies do not normally behave like public sector extension services. To recover their expensive private investments in the development of GM seeds, they seek exclusive rights to sell or license the sale of those seeds to farmers.

Given the lead role of the private sector, developing countries wishing to promote GM crops might consider, at one extreme, a policy of offering the same generous IPR protections currently provided under US patent and trademark law. Advocates of this kind of patent protection say it is one reason US based companies have become world leaders in the development of commercially applicable GM crop inventions.

A slightly less promotional option would be to extend to companies and GM crop developers the somewhat weaker IPR protection provided under the international union for protection of new varieties of plants (UPOV). This plant breeders rights approach is favored over patent protection by most governments in Europe. UPOV strikes an important balance between the rights of plant breeders to capture commercial benefits from innovation and the rights of those same breeders to use protected genetic resources as an initial source of variation in the breeding process. Early forms of the UPOV convention also sought to protect the traditional privilege of farmers to replicate seeds of protected varieties for replanting on their own farms.

The most recent (1991) version of UPOV is the strongest, and nations following this approach will be considered here to have a permissive IPR policy towards GM crops. UPOV 1991 gives breeders IPR protection for 20-25 years, and prior authorization from the holder of these rights is necessary for any production, commercial marketing, offering in sale, or marketing of propagating material of the protected variety. The breeders earn royalty payments for the protected variety, and anyone infringing on these rights may be prosecuted. At the same time, breeders themselves may use protected varieties as an initial source of variation for the creation of new varieties and then market those new varieties without authorization from the original breeders (Dutfield 1999). UPOV 1991 permits member states as well as plant breeder's right (PBR), United States follows this double protection option, but most European countries expressly "forbid patenting of plant varieties and operate under UPOV only.

A weaker but co-existing version of the UPOV convention dating back to 1978 will be classified here as a precautionary IPR policy toward GM corps. Under UPOV 1978, the balance was tilted less toward incentives to innovate or invest in new technologies and more towards options for poor farmers to use technologies that already existed. UPOV 1978 implicitly protected the privilege of farmers to use protected plant varieties for propagation purposes on their own holdings, the so called farmers privilege. This relatively weak UPOV 1978 standard is nonetheless sufficient to meet the minimum PBRs required under the Trade-Related Intellectual Property Rights (TRIPs) agreement of the World Trade Organization (WTO), an international agreement that become binding for many developing countries beginning in January 2000.

At a preventive extreme, developing country governments might decide to offer no IPR guarantees at all to private companies or commercials breeders for newly created varieties of plants or animals. Blocking the spread of GM crop technologies would not have to be the primary motive for taking this preventive IPR policy approach, but the preventive result could be the same (Box 2).

Biosafety Policy:

A second policy venue in which developing country governments must make choices regarding GM crops is the area of biological safety, or biosafety. A number of known hazards to the biological environment must be considered whenever a new plant variety (GM or otherwise) is introduced into a farming ecosystem. These include harmful competition with or direct damage to desirable species, unwanted gene flow (including transgene flow) into close relative species, unwanted resistance to herbicides among weeds or unwanted resistance to insecticides among pests, the creation of new strains of viral pathogens, and undesired losses in biodiversity. Environmental advocates have worried that the risks of such biosafety hazards from novel GM crops might be greater than from conventional crops.

When choosing a biosafety policy toward GM crops, developing countries can again be promotional, permissive, precautionary or preventive. Governments wishing to be fully promotional might either impose no biosafety screening at all for new GM crops or give routine approval to any new crop approved elsewhere. Commercial release of new GM seeds into the farming environment could then proceed as soon as the transgenic seeds were bred for the agronomic traits (such as color, yield or cooking properties) desired by local farmers.

A permissive approach would be to test GM corps on a case-by-case basis for the same known biosafety risks that have long been associated with conventional crops. Under this approach GM crops would not be singled out because of their novel transgenic nature as inherently more dangerous, they would be screened for biosafety risks in the same manner that non-GM crops have long been screened for such risks. This is permissive approach in the sense that it does not set a higher biosafety standard for GM than for non-GM crops. Yet it may not be a lax or a lenient approach if the biosafety standard being met are set sufficiently high. The US government follows this permissive approach and claims that its standard for screening both GM and non-GM crops have so far been high enough to protect against any documented bio damage (committee on science 2000).

Most of the industrial nations beyond the United States, and many developing countries as well, are more inclined to view GM crops as sufficiently novel to required separate and more cautious biosafety consideration. This precautionary approach singles out GM crops for tighter biosafety regulation because of their novelty and the scientific uncertainties that are always associated with novelty. Under this approach, government would slow down or hold back on the field testing or commercial release of GM crops not just to avoid biosafety risks that are known and have been demonstrated, but also to avoid some risks that may not yet be known or are still undemonstrated.

At an even more cautious extreme, a fully preventive approach to the biosafety of GM corps might be adopted. Under this approach, new GM crop varieties would not be screened for risk case by case; instead the presence of risk would be assumed without testing because of the novelty of the GM process alone, and permission to release GM crops into the environment would be denied (Box 2).

Trade Policy:

In the area of trade policy, the gradient from promotion to prevention is more difficult to describe because consumer and importer acceptance of GM crops in international commodity markets is uncertain and evolving. Assuming consumers and importers accept GM crops, a developing country hoping to promote those crops would plant them with confidence, knowing they would cut production costs and increase export competitiveness. However, if consumers and importers increasingly reject GM crops, developing countries seeking export sales might be induced to ban GM crops internally so as to be able to offer bulk commodities to the world market with a GM-free label.

The promotional trade policy toward GM crops is one that

1) Promotes planting of GM crops in hopes of reducing farm production cost, thus increasing price competitiveness.

2) Permits GM commodities, seeds, and plant materials to come into the country with little or no restraint.

A permissive trade policy would neither promote nor prevent the planting GM crops internally and might regulate imports, but in a way that draws no invidious distinction between GM and non-GM imports. A permissive policy would follow the WTO's science-based standards for sanitary and phytosanitary (SPS) trade restrictions (Roberts 1998).

A precautionary trade policy towards GM crop would impose a separate and more restrictive set of regulations on trans-boundary movements of GM plant materials and seeds. Such special regulations might take the form of additional testing or information sharing requirements and procedures, labeling requirements, or prior notification requirements. One framework for this precautionary approach is the Advance Informed Assent (AIA) agreement incorporated into Cartagena protocol on biosafety, negotiated in January 2000 within the Convention on Biological Diversity (CBD 1992, 2000).

If strict enough, precautionary import regulations might present such an inconvenience to exporters as to block virtually all movements of GM materials, seeds or commodities into the country. In that case, the policy would have to be classified as preventive rather than precautionary. Imposing an outright ban or an open-ended moratorium on imports of GM material would be a more direct way of embracing a preventive policy approach. One emerging trade policy motive for a preventive approach toward GM crops has been the recent international consumer backlash against GM. If this backlash continues to strengthen, banning GM crops at home could be one way for developing countries to strengthen their attractiveness as a source of bulk commodities in the eyes of industrial country importers in Europe or Japan (Box 2).

Food Safety and Consumer Choice Policy:

Issues of food safety and informed consumer choice tend to dominate the public debate over GM crops in the industrial world while remaining less salient in most developing countries. Food safety is of course a serious problem in poor countries, but the principal dangers come more from already demonstrated hazards – such as unclean water, lack of refrigeration, and unsanitary condition for food transport, storage, marketing, and preparation than from speculative hazards associated with the GM content of foods.

Nonetheless, a gradient of developing country policy choice toward GM foods, from promotional to preventive, can be drawn. At a promotional extreme, these governments might be reassured by the evidence developed so far through testing and actual consumption in the developed world and conclude that the food safety risks posed by the

GM crops already on the market in rich countries are no greater than the risks posed by the non-GM equivalents of those crops (Nuffield Council on Bioethics, 1999). Their policy response would be to require no new testing or labeling procedures for those already-approved GM crops. Only if GM food were significantly different from its conventional counterpart (for example if the nutritional value were different or if it caused allergies) would a label be required to indicate that difference. Such an approach would mimic the promotional approach taken so far by the United States.

Following a slightly more heedful approach, government might conclude that even if new risks specific to GM foods have not been demonstrated by scientists, consumers still have some right to know when they are consuming GM foods. Following this approach (classified here as permissive) governments might require food companies to designate as "GM" if more than a specified percentage of the content come from GM crops. Consumer choice policies in some EU countries have at times tried to follow this permissive model (EU 2000).

Under a still more precautionary approach, governments would require labeling for all GM foods, including fresh and processed foods. The only way to enforce such a requirement would be to require totally segregated or "identity preserved" marketing channels for GM versus non-GM foods, all the way from the farmer's field to the consumer plate. That would be a costly option for any nation growing, importing, or exporting GM foods, as it would require an expensive duplication of equipment and facilities in the food transport, storage, and processing sectors (USDA 2000). Yet it would be the only way to give all consumers a fully informed choice.

A preventive approach in this area would ban all internal sales of GM foods. This approach might be taken as an ultra-precautionary step to protect domestic consumers against hypothetical or unknown risks. For countries not yet growing GM crops, a total ban might even have the attraction of being cheaper than the precautionary "fully informed choice" approach because it would avoid the need to segregate markets and duplicate food-handling infrastructures. This advantage however, would be gained at the cost of eliminating all consumer choice. A softer preventive approach might be to require stigmatizing labels on all GM foods, describing them (even without any scientific evidence) as dangerous to consumers (Box 2).

Public Research Investment Policy:

Public investments in agriculture research have helped developing countries generate high rates of economic return from higher farm productivity growth. How to allocate these research investments across different crops or farming systems has always been a difficult policy problem for national agricultural research institutes, given the persistent scarcity of funds available for any kind of research activity in the developing world. With the emergence of transgenic crop technologies, national research institutes now face a new choice. Should they invest scarce treasury funds or scarce donor funding in this new technology? In those developing countries where private corporate involvement or investment in the farm and seed sector has not traditionally been welcomed or, conversely, has been hard to attract, the investment of treasury funds may be the only way to launch a GM crop revolution.

At a promotional extreme, then, governments might invest their own treasury funds on the actual development of their own GM crops. One motive might be to steer GM technology development toward the crop most critical to low-resource for communities that tend to be "orphaned" by researchers in the profit-making private sector.

A slightly less promotional approach would not invest in the development of new GM crops but only in the transfer (back crossing) of already developed GM crop traits into local crop varieties. That is, rather than trying to compete with the international companies and research centers that have already developed potentially useful GM crop applications, developing-country governments would seek agreements with those companies or institutes to permit the transfer of already-developed GM crop traits into local crops germplasm.

A more precautionary approach toward public sector research would allow backcrossing of GM traits into local cultivars but would not spend any significant national treasury resources for that purpose. If donors or international agricultural research centers wanted to sponsor the introduction of desirable trangenes into local germplasm, and if they wanted to finance the associated upgrade that might be needed in biosafety facilities or personal training, that would be welcomed. But treasury funds would be reserved for more traditional agricultural research activities, perhaps including non-GM biotechnology research in areas like tissue culture or molecular maker-assisted breeding.

A preventive approach would make no investments at all (of either treasury funds or donor funds) in any transgenic technology development or adoption work (Box 2).

Box 2: Policy Options Toward GM Crops.

	Promotional	Permissive	Precautionary	Preventive
Intellectual property rights	Full patent protection, plus plant breeders rights under UPOV 1991	PBRs under UPOV 1991	PBRs under UPOV 1978, which preserves farmers privilege	No IPRs for plants or animals, or IPR on paper that are not enforced
Biosafety	No careful screening, only token screening or approval based on approval in other countries	Case by Case screening for demonstrated risk, depending on intended use of product	Case by case screening also for scientific uncertainties owing to novelty of GM process	No careful case by case screening, risk assumed because of GM process
Trade	GM crops promoted to lower commodity production costs and boost exports; no restriction on imports of GM seeds of plant Materials	GM crops neither promoted nor prevented; imports of GM commodities limited in same way as non GM in accordance with science based WTO standards	Imports of GM seeds and materials screened or retrained separately and more tightly than non-GM; labeling requirements imposed on imports GM foods or commodities	GM seeds plant imports blocked; GM free status maintained in hopes of capturing export market premiums
Food safety and consumer choice	No regulatory distinction drawn between GM and non-GM foods when testing or labeling for food safety	Distinction made between GM and non GM foods on some existing food labels but not so as to require segregation of market channels	Comprehensive positive labeling of all GM foods required and enforced segregated market channels	GM food sales banned, or warning labels that stigmatize GM foods as unsafe to consumers required
Public research investment	Treasury resources spent on both development and local adaptations of GM crop technologies	Treasury resources spent on local adaptations of GM crop technologies but not on development of new transgenes	No significant treasury resources spent on GM crop research or adaptation; donors allowed to finance local adaptations of GM crops	Neither treasury nor donor funds spent on any adoption or development of GM crop technology

Source: Paarlberg 2001.

INDIAN POLICY TOWARDS GENETICALLY MODIFIED (GM) CROPS

Intellectual Property Rights:

India has traditionally relied on its own public sector scientists and government extension agents rather than domestic or international private companies to develop and extend productive new agricultural technologies. While taking this approach India has felt little need to offer IPR guarantees to private companies or plant breeders in the area of crop development (Paarlberg, 2000). By 1991, however, India's agricultural research establishment concluded it was necessary and prudent to move the nation's IPR policies closer to international standards (Selvarajan, Joshi, and O'Toole 1999). Accordingly, a draft Plant Variety Protection Act (PVPA) was submitted to parliament in 1993. This decision to move toward a minimal plant variety protection law resulted in emotional debate in India's parliament. While the first draft of PVPA criticized by the private seed companies as too weak, the NGOs claiming to represent farmers group warned it was too strong and would allow professional plant breeders and private companies to appropriate some of the crop improvements that traditional farmers had been making for thousands of years. Consequently a revised draft was produced in 1996/97 to address this farmer's right issue. India's cabinet then approved the revised draft in October 1997, but under intense NGOs criticism Parliament continued to stall. A revised December 1999 version of the PVPA is currently working its way slowly through parliament (Government of India 1999). Pending final passage to PVPA, India's IPR policies toward GM crops must be classified as preventive (Box 3). Partly because of these weak IPR policies, international life science companies interested in the Indian market for GM products have so far been willing to bring only hybrid GM varieties into the country. IPR protection is less critical for these hybrids because the valuable traits of the seed are mostly lost after the first planting (Paarlberg, 2000).

Biosafety:

In the area of biosafety, however, GM crops themselves were always the issue. The Indian government began issuing biosafety guidelines for handling GM organisms in December 1989(DBT 1990, 1998). These guidelines were borrowed partly from the United States, and at the research stage they required screening of GM crop technologies only for risks that could be scientifically demonstrated (Ghosh, 1997, 1999; Ghosh and Ramanaiah 2000). The guideline created two separate committees with policy authority: a Review Committee on Genetic Manipulation (RCGM) empowered to approve (or not approve) applications for all small-scale research activities on GM crops in India, and a Genetic Engineering Approval Committee (GEAC) empowered to approve (or not) large-scale research activities as well as actual industrial use or environmental release. The RCGM is established within the Department of Biotechnology (DBT) and naturally has a pro research bias. The GEAC is chaired by the ministry of Environment and Forests (MOEF) opening the way for a more precautionary approach to biosafety questions.

So far the biosafety approval system has been, on balance, more cautious than permissive, as illustrated by the case of Bt cotton. India's cotton farmers are plagued by bollworms that have become resistant to chemical sprays. Insecticidal Bt cotton presents an alternative method to control bollworms, yet efforts by Monsanto/Mahyco since 1997 to gain biosafety approval for Bt cotton from RCGM and GEAC have repeatedly been slowed by NGO protests. By filing lawsuits against RCGM for authorizing Bt cotton field trials in 1998, and by sponsoring physical attacks against those field trials, anti GM activist groups in India have transformed the biosafety approval process into a highly politicized and at time paralyzed policy struggle. India's finally did approve large-scale field trials for Bt cotton in July 2000, a move that pleased Monsanto/Mahyco but antagonized GM crops critics, who field a new petition against the trials. The GEAC decision stopped short of approving Bt cotton for commercial release, so on biosafety it is still not legal for farmers in India to grow any GM crops[1] (Box 3).

Trade:

To accompany its policy of not yet growing any GM crops commercially at home, India has also attempted so far to block most imports of GM commodities into the country. In export markets, India is now using its nominal GM free status to seek price premiums. India is an exporter of soybean meal and recently promoted its Soy, Sunflower, and Rapeseed meal exports as GM free when selling to markets in Indonesia, Japan, Thailand, the Persian Gulf countries, and the Middle East (APBN, 2000). However, since most of these sales are for animal feed purposes rather than direct human consumption, price premiums have been difficult to secure. Nevertheless, India meal exporter have begun hoping that Asian countries, such as Thailand, which export chickens to the GM conscious European market, will soon see the advantage of buying feed from a GM free

[1] In march 26th 2002 permission for commercial release of India's first GM crop the Bt cotton was granted by Genetic Engineering Approval committee of Government of India.

supplier such as India rather than from United States.

Food Safety and Consumer Choice:

Because India does not yet officially grow or import any GM foods, it has been able to get along with food safety policies that draw little or no distinction between GM and non-GM food ingredients. In 1998, however, India revised its GM crop biosafety approval guidelines to require that GM seeds, plants, and plant parts be screened for toxicity and allergenicity (DBT 1998). This new RCGM procedure singling out GM gives India a permissive rather than a fully promotional safety policy toward GM foods (Box 3).

Public Research:

The Government of India, through its Department of Biotechnology (DBT), has for more than a decade directed a small but steady stream of treasury resources toward the development as well as local adaptation of GM crop varieties. Between 1989 and 1997, DBT spent a total of nearly 270 million rupees from the treasury (roughly US$ 6 million) on plant and molecular biology research with project focused primarily on development of transgenic plants (Ghosh 1999). In 1998-99, the total DBT research budget across areas (agriculture and non-agriculture) was 1040 million rupees (roughly US$ 26 million). About 15 percent of this, roughly 153 million rupees (or US$ 3.8 million), went for plant biotechnology. DBT investments in transgenic plant biotechnology in 1998-99 totaled roughly 51 million rupees, or about US$ 1.3 million. The resources that DBT receives from planning commission and ministry of finance are quite modest, despite the fact that senior political leaders frequently list biotechnology as among the keys to India's future growth and prosperity[2]. Because these investments have gone for development as well as local adoption, India's public research investment policies toward GM crops deserves to be classified here as promotional (Box 3).

Box 3: Policies Toward GM Crops in India.

	Promotional	Permissive	Precautionary	Preventive
Intellectual property rights				Until India enacts its draft plant variety protection law and joins UPOV, IPRs not protected
Biosafety			RCGM and GEAC have moved slowly on biosafety approvals, fearing Criticism from anti-GM NGOs.	
Trade				GEAC has not formally approved GM commodity imports; efforts has been made to seek premiums for GM free products in export markets
Food safety and consumer Choice		RCGM and GEAC require some testing of GM and non-GM foods; no separate GM food Labeling is required since GM foods are not officially on the market		
Public research Investment	Modest treasury funds are spent on independent GM crop development			

Source: Paarlberg, 2000.

2 At the 87th Indian science congress in Pune in January 2000, prime minister Atal Bihari Vajpayee said that Indian science and technology, including information technology, biotechnology, and other knowledge –based sectors of science and technology were going to be the propellers for India's next big leap forward.

Developing Appropriate Biotechnology Policies for Food Security in India:

India is facing real challenges with a multitude of problems like poverty, hunger, economic inequality, ethnic strife, urban congestion, food and water shortages, institutionalization of corruption, exploding population, and serious concerns about its water and food quality (Parkash, 1999). Governments deciding whether or not to invest in agricultural biotechnology need to determine where the most demanding needs and priorities lie and if biotechnology can meet those needs and fit those priorities. The key step is to ascertain the identity of the considerations in agriculture that customary methods has not been able to conquer and novel scientific findings that offer new ways out of the constraints. These priorities ultimately need to be set by aggregating the perspectives of economists, policymakers, scientists and the end users. Policies must amplify and escort research and technology development to resolve the problems of specific importance to the poor. These problems include diets with imperfect levels of energy, protein, and micronutrients, and yield losses due to biotic and abiotic factors. Research should focus on the crops of particular importance to small tillers of the soil and livestock breeders and poor consumers in India.

To instruct biotechnological based methods into India's agricultural sector certain spheres are needed to be given specific mindfulness, they comprise, research, biosafety, and food safety, intellectual property rights, research funding, and delivery of products.

There are three ways to expand biotechnological research for the benefits of the poor. First, designate additional public resources to agriculture research, including biotechnology research that pledges large social gains. Second, expand private sector research for the poor by converting some of the social benefits of research to private benefits for the private sector. The public sector can allure the private sector to develop technologies for the poor by offering up front to buy the exclusive rights to freshly developed technology and make it available either for free or for a nominal charge to small farmers. The sum of the offer could be settled on the basis of expected social benefits. The third way to expand biotechnology research to assist the poor is to harbor intellectual property rights of the private research bureau that develops a particular technology. For example seeds with infertile offspring, or that contract directly with the farmer, in both cases driving the farmer to buy new seeds every season. This would make it easier for the private sector to recuperate the returns needed to justify the research.

Effective national biosafety and food safety regulation should be in place before biotechnology is broached into agriculture system of India. Such regulation should be specific to India's situation and resonate pertinent risk factors. The ecological risks policymakers need to assess include the spread of traits such as herbicide resistance from genetically modified plants to plants (including weeds) that are not modified, and build up resistance in insect population.

The four major elements of effective biosafety systems are:

1. Written guidelines that clearly define the structure of the system, the roles and responsibilities of those involved and the review process;
2. The regulatory authorities themselves, who should comprise an in-country cadre

of well trained individuals, confident about their decision making ability, and about support of their institutions;

3. An information system that enables the biosafety evaluation process to be based on up to date and relevant scientific information and the concerns of the community;

4. Feed back mechanisms for incorporating new information and revising the regulatory systems as needed.

Research in agricultural biotechnology has to be conducted over the long time and without interruption. Uncertain financing therefore can severely interrupt the research process. Reasons that reported for funding constraints include:

1. Implementation of fiscal austerity policies.
2. Lack of understanding of biotechnology among decision makers
3. Insufficient research impact.
4. Dependency on fund from sole source, particularly government or donors, and;
5. Lack of political and financial support from agribusiness and from farmers and their organizations.

Public sector funding can be attracted by documenting and publicizing research impacts, developing strong and fluent client organization that have political influence, building closer relation between biotechnology leaders and policy makers, and swelling the funding base to include environment and commerce departments. Strategic alliance between public and private sector entities can also expand the financial resources for agricultural biotechnology.

Decision about the generation of products and their deliverance to users must be considered at an early stage of a research program. These decisions need particular attention in R and D programs involving biotechnology, because product dissemination is affected by factors such as the costs of large-scale production, biosafety and risk assessment, and public acceptance of the final product. Collaboration or joint ventures between the private sector and public institutes or universities is fundamental for successful product delivery. In some cases, specialized national or international organizations have facilitated technology transfers from public to the private sector that have led to the diffusion of new products.

Epilogue:

Prometheus changed the world forever when he unleashed the forces of innovation and creativity. The Promethean scholars of today seek to use the new discoveries in molecular biology and genetics to understand and protect the natural world and productivity of agricultural systems. These developments are being driven by scientific and industrial wealth of industrial world. It is there that the early benefits of biotechnology are accruing. It is also where the debate as to the wisdom of using modern biotechnology at all is fiercest.

Modern biotechnology offers promise to increase the productivity of the agriculturally important species in the developing countries including India. However, this unlikely to happen in time if present trends continue. The development of relevant and appropriately fine-tuned application in India and other developing countries will be hampered by the lack of access to the scientific and financial resources. This can be solved by timely implementation of proper policies in regard to diverse issues, which are related to biotechnology.

Failing to do so means that the potential of the human and natural resources of India will not be fully realized and India will be a poorer country.

Creativity in finding solutions to these policy and institutional impediments to innovation are as important and challenging as new scientific discoveries, if the promises of Promethean science are to be realized. Even more, the ability to link the findings and techniques of the new biological and genetic sciences within a framework that respects the agro-ecology of smallholder farming systems, and integrating all of that with the wisdom of the farmers themselves is the key to where a better future for all lies.

Chapter 9

Conclusions and Suggestions

MAJOR FINDINGS

Food security has been defined as access by all people at all times to enough food for an active, healthy life. Its essential elements are the availability of food and ability to acquire it. However, the most important fact is that food security is a complex issue that involves; not just production, but also access, not just output, but also process, not just technology, but also policy, not just global, but also national, not just national but also households, not just households, but also individuals, not just rural but also urban, and not just amount but also content. Food security often considered at different levels such as global, regional, national, sub-regional, households and individuals. While the early concerns had been mainly confined to global and regional food security, during the last two decades the focus has been shifted to food security concerns at the national, household and individual levels. This shift has modified and enlarged the concept itself. Food security has at least three dimensions including, availability of enough food for entire population, accessibility of food for all sections of population and nutritional adequacy.

In relation to national food security, there are indications that the production performance of Indian agriculture during the 1980s has maintained a satisfactory growth rate, but there are indications of fall in growth rate during the 1990s. The fall in the growth rate has been more pronounced during the *Kharif* season than during the *rabi* season. With negative growth rates in area under food grains, mainly coarse cereals and reduced growth rates in yield as compared to the levels achieved during the 1980s.

The trend in per capita production indicates a consistent upward tendency for cereals and a consistent downward tendency for pulses. Between 1980s and 1990s there has been a decline in the variability in yield and production of all cereals and pulses. The variability in per capita availability of cereals remained at a lower level than the variability in per capita production. The trend in slowing yields and production in India is more of a supply phenomenon and thus more of a cause of concern. Although, there have been fluctuations in the year-to-year per capita availability of food grains, the underlying trend has been one of increase. From an availability of 394.6 grams of food grains per capita per day in 1951, which amounted to 86 % of the basic requirement of 400 grams per day, physical availability has risen to 458.6 per day grams in 2000, which is 115 % of the requirement. Energy and protein supplies in India only grew at a rate of 1 percent per year between 1980 and 1995.

With somewhat satisfactory levels of national food security influenced by the production performance of Indian agriculture during the past decades, attention has been shifted from national food security concerns to individual and household food security. While household food security is influenced by both physical access and economic access, food security of individual members of the household is influenced by intra-household allocation of food. Out of four standard methods of measurement of food security *(Individual Calorie Intake, Household Calorie Acquisition, Diet Diversity and Index of Copping Strategy)* keeping in mind availability of secondary data, *Individual Calorie Intake* method has been selected as method of measurement food insecurity. Available data on food consumption pattern indicates that about 286 million people had nutritionally inadequate food consumption level, out of which 180 million or 63 % are living in rural areas and 106 million or 37 % are city dwellers.

However, the problem of food insecurity in this work is not summarized to only measurement of food security in calorie term. Risk of entitlement failure also has been measured for both rural and urban areas. To measure risk of entitlement failure on the basis of Engles law a simple method based on individual per capita expenditure data has been developed and expenditure classes have been classified on their respective risk class. The findings are striking, while 70 % of people in India could be branded as food secure, their entitlement to food have been fixed with high degree of risk, as in rural and urban areas 95 % and 70 % of population are to some degree at risk of losing their food entitlement.

To provide a minimum level of food security (on physical terms) in the year 2020, India needs a growth rate of food grain production of 3.5% to 4.5% between 2000 and 2020 while the actual growth rate stagnate at the level of 1.8% during 1990s. The growth rate of food grain production required to ensure physical access to the level needed to ensure minimum food security by 2020, is appeared to be modest. However, it is conditioned by two important considerations; the declining trend in the population growth rate should be maintained and that the declining growth rate in the production of food grains experienced during the 1990s should be reserved.

The new production targets have to be achieved in the situation where soil erosion, air pollutions, soil compaction, aquifer depletion, the loss of soil organic matters are accepted fact. It is also accepted that future growth in food supplies must come from yield increasing technological changes. Expanding production into new areas has reached its limits. Agriculture has already moved into marginal zones where sustainable production is not feasible with current levels of technology and where there are long-term negative environmental consequences.

Furthermore, the current food policy of India and its shortcomings has been examined, the current food policy resulted in overflowing food stock, with a high financial cost for central as well as states government, and a subsidy system which is both inefficient and unsustainable as it takes in some states more than 2 Rs to transfer 1 Re subsidy to the poor people. Moreover, in the year 2001-02 only 58.4 percent of government subsidies in India could be branded as consumers subsidy the rest is going on operation of FCI or cost of stock keeping.

While some people think the globalization and consequent integration of Indian economy in general and Indian agriculture in particular with global economy would totally damage India's food security position, the data indicates that on the whole India will benefit 2.1 billion US $ from agricultural trade liberalization by the year 2020, available calorie supply will increase from 2332 calorie in 1990 to 2711, percentage and number of malnourished children will reduce from 63% and 70.86 million respectively in 1990, to 43.91% and 46.07 million in 2020. However, at micro level especially in agriculture sector it will create both losers and winners as it has already created in different parts of the world. More importantly the negative impacts of globalization in Indian agriculture sector are not as a result of nature of process of globalization itself, but they are result of fall in government investment in agricultural infrastructure and research and high level of domestic subsidies that provided by governments of developed countries to their farmers. In considering the nature of globalization, we need to look at more than trade liberalization and economic aspects, although they are very important. We should also examine increased non-economic linkages (political, social, and cultural) that create new alliances. We need to ensure that globalization does not make exceptions and boxes, but follows rules of global interaction and cross-border interaction that are dedicated to sustainability and people. What need to be done is to shape globalization such that it benefits the poor and contributes to ensure their food security.

Even as, other developed as well as developing countries are implementing agricultural biotechnology to solve their food and agricultural problems and create income and wealth in rural areas that can contribute to overall food security and well being of society, India is lagging behind in its implementation. It is due to the fact that Indian policies toward most the issues related to agricultural biotechnology are far from being promotional. With over 50 approved GM foods, over 52 million hectares of transgenic crops in 13 developed as well as developing countries and over 300 million humans consuming GM foods in North America since 1994, any inherent dangers with GM as a technology should have been apparent by now. Not one problem has been documented. Used responsibly, biotechnology can advance India's agriculture to address the challenge of feeding its increasing population with its limited economic, land and water resources.

CAN FUTURE NEEDS BE MET?

Since the mid 1960s, the growth of agricultural productivity both in terms of yield gains achieved and total food production has been impressive, and the yield gains achieved hold promise for making future gains. However, a word of caution must be raised. Achieving needed future gains will depend on expanding the knowledge base as well as on developing an array of new technologies to support the needs of ever-expanding populations.

But, future gains will come harder as India moves up on the yield curve. More critical production problems enter the picture the higher country move ups the yield curve. Staying at present yield level, or moving beyond current boundaries, requires well-trained scientists working in effective institutions with ensured continuity and funding.

Meeting tomorrow's food needs will require continuing genetic improvement of crops, to provide an array of high-yielding, robust plant materials with resistance to pests and diseases, and with increase tolerance to limiting soil, water, and temperature conditions. The genetic strategy in agricultural improvement is still powerful and shows promise of moving even faster as new tools from molecular biology come on stream.

In current circumstances, yield-related research tasks are studying how to maintain productivity, close yield gaps, and raise yield potential. India should have a strategy to carry out research to satisfy each of these needs, either alone or in partnership with national and international research institutions. Without such a strategy, yield performance may suffer.

In the future, management of inputs also must become more efficient, to get maximum benefit of inputs while causing minimal environment effects. Management must be even more intensive and based on sound information and increased knowledge. All signs indicate a much more intensive and productive agriculture that must be under guided with a knowledge-generating and knowledge-synthesizing system that helps to lead to an array of improved technologies from which millions of farmers can choose in running their respective individual enterprises.

India will be able to produce the food needed to feed the projected population of 1200 to 1400 million in 2020. It can be done with little negative impact on the environment. But it can not be attained without permitting the use of technologies now available, or without research to further improve and utilize new technologies, including biotechnology and recombinant DNA. While the Green Revolution, with its dramatic yield increases, enabled us to remain self sufficient into the 1980s, the technology has now packed. Now genetically enhanced crops could lead the way.

For the last 10 years, we have had food created by traditional methods of genetic modification. Today, science offers huge improvements over earlier methods. It allows us to modify a plant with an exact genetic input, inserted with a precise purpose a trait we understand. The first generation of genetically modified crops enhanced traits like resistance to insects, reduced pesticide needs, better control of weeds, bigger yields. Crops in the research pipeline will deliver vitamins or vaccines, be nutritious, resist spoilage, use less fertilizer and grow better under extremely dry or saline conditions.

DRIVING FORCES

There are many factors that will influence the prospects for sustainable food security in coming years. Eight sets of driving forces believed to be of India's importance are identified here.

1. **Acceleration of Globalization Including Further Trade Liberalization:**

Globalization offers India significant new opportunities for broad based economic growth and poverty alleviation, but it also carries significant risks. There are five major pathways by which globalization may affect food consumption and nutrition: (i) Trade flows generate rural income, increase foreign exchange through agricultural exports and alter prices in domestic markets, these change in turn affect dietary patterns and food production composition; (ii) financial flows affect the real income of farmers and households, which in turn affect country's capacity to buy food imports; (iii) The major advances in technology, transport systems, and other new technologies such as genomic and molecular breeding, transform the traditional organizations of production and marketing, facilitate agricultural and rural development, and unable a more micronutrient-rich diet to be achieved; (iv) improved access to information and easier communications allow to find out about new nutrition initiatives, help determine the latest thinking on existing nutrition problems, provide a forum for debate on nutritional issues and help mapping food production and malnutrition by region; and (v) the increasing integration of labor markets implies opportunities for non-farm income, promising new avenues for exports and non-farm work.

The most critical issue is how globalization can be guided to benefit low-income people, particularly their food and nutrition situation as well as the impact on natural resources. Without appropriate accompanying policies and institutions at both national and regional levels, globalization may either bypass or harm many poor people in India.

2. Sweeping Technological Changes:

New technological advances in molecular biology and information and communications offer potential benefits for poor people that may advance food security and improve the sustainability of national resource management. However, there are serious concerns over whether poor and food-insecure people will have access to these technologies, many of which currently are focused primarily on non-poor people in industrialized countries. While past agricultural research tailored to solving problems of small-scale farmers and low-income consumers in developing countries has been effective in expanding productivity, protecting the environment and increasing food security, rapid changes in the financing, management, and organization of agriculture research, including widespread patenting of living organisms may require new policy interventions to further enhance the benefits obtainable by low-income people. Without such changes in policies and institutions, the current and expected technological revolutions may leave the poor and food insecure further behind.

3. Degradation of Natural Resources and Increasing Water Scarcity:

Degradation of natural resources is rampant in many resource-poor areas, particularly those areas with fragile soils, irregular rainfall, relatively high population concentration, and stagnant productivity in agriculture. Natural resource degradation is also occurring in agricultural areas exposed to misuse of modern farming inputs. While natural resource degradation often is a consequence of poverty, it also contributes to poverty. Such a downward spiral is found in many locations where low-income people reside. Water scarcity is emerging as the most constraining factor for food security in many regions in the future. Failure to effectively deal with the natural resource issue in the quest to achieve food security for all will not result in sustainable solutions.

4. Rapid Urbanization:

Urbanization will bring with itself new challenges to provide employment, education, health care, and food. While current actions must continue to focus on rural areas where the majority of the poor and food insecure reside, future policy actions must pay increasing attention to the growing poverty and food insecurity in urban areas.

5. Climate Change:

Many scientists and policy makers believe that climate change is leading to more frequent and more severe natural disasters. More research is needed on this hypothesis, as it has profound implication for food security. Future agricultural policies must focus on finding ways to keep agriculture productive as climate change continues.

6. **Health and Nutrition Crisis:**

Malaria, tuberculosis, micronutrient deficiencies, HIV/AIDS, and chronic diseases are all compromising food and nutrition security in many developing countries like India. These global health crises not only destroy human lives, but also slam the door on opportunities. They are impoverishing millions of people, raising the cost of health care, and causing severe shortages of productive workers.

7. **Changing Roles and Responsibilities of Key Actors:**

The diminished and changing role of national governments in many developing countries including India, which has been under way over the last couple of decades, is likely to continue into the future. Given the importance of public goods, what is the most appropriate role of government in effort to achieve food security? Local governments along with the private sector and civil society, including non-governmental organizations (NGOs) are taking on an increasing number of responsibilities for activities previously undertaken by government. Local communities, frequently with the help of community-based non-governmental organizations are demanding an increasing say in policies and programs that impinge on them. At the global level, trans-national corporations and broad coalitions of civil society organizations are taking on increasingly prominent roles in policy debates and in actual national and international policy formulation. New emphasis on exposing corruption and other bad governance where it occurs is likely to contribute to the ongoing changes in the roles and responsibilities of the various actors.

8. **Getting the Priorities Right:**

Achieving sustainable food security for all will depend on policy action and institutions that address the causes of food insecurity, malnutrition, and unsustainable management of natural resources within the context of the driving forces. The specific policies that will be most appropriate will vary according to local and national circumstances.

Rapid pro-poor economic growth together with empowerment of the poor and effective provision of public goods will be the backbones of any successful attempt to achieve sustainable food security for all. Policies and institutions should be designed and implanted to guide economic growth and public goods creation for the benefit of low-income people, and the poor must be empowered through human resource development, access to productive resources, and participatory political systems. The following nine broad areas of policy action are likely to be relevant, both for India and for most developing countries.

PRIORITIES FOR POLICY ACTIONS:

So, within this changing environment, what steps have proved to be most effective at achieving food security? To begin with, rapid economic growth is essential for achieving sustainable food security for all by 2020. The challenge is to achieve that growth in a way that benefits the poor, that is, pro poor economic growth. This kind of growth, together with empowerment of the poor and effective provision of public goods, will be the foundation of any successful attempt to achieve the vision of food secure India.

1. **Investing in Human Resources:**

Investment in human resources is essential both to improve the well-being of the individuals affected and to promote broad-based economic growth and sustainable food security. Policies and institutional change should focus on improving access to health care, clean water, safe sanitation, and childcare. Efforts should be made to fight widespread micronutrient malnutrition; universal primary education for girls and boys is of critical importance. Policies and behavioral changes should be pursued to achieve gender equity in human resource development, access to resources and decision-making.

2. Family Planning:

Closely associated with investments in human resources, it is important that families be given access to family planning in ways compatible with their desires and cultures. Efforts should be made to help families attain the desired number of children within the social and cultural context in which they live.

3. Improving Access to Productive Resources and Remunerative Employment:

Broad-based agricultural and rural development is essential to generate pro-poor economic growth. With 63% of food insecure people living in rural areas, productivity gains in agriculture and other rural enterprises are urgently needed. The rural poor must have secure access to land and/or other productive resources and employment. Policies and institutions are needed to facilitate access by poor rural families to inputs and appropriate technologies as well as non-farm employment. Promotion of small-scale rural enterprises providing goods and services for farm families as well as rural based agro-industries that create employment and add value to agricultural produce should be pursued. Access to credit and saving institutions, is of critical importance. While the gravity of food insecurity and malnutrition will continue to be in rural areas for many years to come, rapidly increasing urban poverty requires new policy attention to enhance access to income-earning opportunities and to provide the necessary public goods in urban areas. Policies and institutions should facilitate effective contribution by civil society, including farmers associations and local and national non-governmental organizations (NGOs). National policies and institutions should complement and support community action, and include low-income people as active participants rather than passive recipients. Women should be empowered to gain access to resources and decision-making processes, and social and cultural institutions and practices that prevent women from reaching their full potential should be reformed.

4. Improving Markets, Infrastructure, and Institutions:

Benefits from improved human resources and access to productive resources will be captured by poor people only if they have access to well-functioning markets for outputs, inputs, consumption goods, capital, and employment. It is particularly important that governments assure that markets are not biased against small farmers, less-favored areas, or poor consumers. Efforts to develop private competitive markets serving food-insecure people must include competent public administration for contract enforcement, grading and quality control standards, market conduct and investments, safety net programs, public health and food safety, appropriate infrastructure such as roads, electrification, and storage facilities, and other policies and institutions. Explicit and implicit capital subsidies as well as infrastructure investments biased against small farmers should be eliminated.

5. Expanding Appropriate Research, Knowledge and Technology:

Technological developments in the biological sciences, energy, information, and communications offer new opportunities that could benefit poor people and their food security. Public investment in research and technology is needed to develop the kind of technology needed by low-income producers and consumers, and to help them gain access to such technology. Pro-poor agricultural research must exploit all appropriate scientific tools and methods, and provide low-income farmers and consumers choices. Farmers and consumers should be fully informed about their options and they should be participants in setting priorities for research. Every effort should be made to ensure that promising technological development do not bypass poor people. Opportunities for using modern information and for using modern information and communications technology, along with non-traditional energy sources, should be fully exploited for the benefit of low-income people.

6. Good Governance:

Good governance, including the role of law, transparency, lack of corruption, conflict prevention and resolution, sound public administration, and respect and protection for human rights, is of critical importance to assure sustainable food security. While the role of the state has changed markedly during the last decades, national and state governments are still the most appropriate and frequently the only major supplier of essential public goods. Where government fails to take appropriate action, food security fails. Hunger persists largely because of governance and policy failure at the national level.

7. Sound National Trade and Macroeconomic Policies:

National policies and institutions are needed to guide globalization for the benefit of the poor. Stable and predictable macroeconomic policies along with sectoral policies and investments in infrastructure should be pursued within a sound governance framework. As globalization proceeds, new national institutions will be needed to assure that low-income people benefits. These institutions shall work closely with civil society and government to identify and remove factors that adversely effect poor people, including price distortions; intellectual property rights regimes adverse to poor people, and barriers to access to appropriate technology.

8. Micromanagement of Yield-Growth Factors:

Yield growth in the past resulted mostly from the use of high-yielding varieties, fertilizer, plant protection materials, and improved farm management practices in irrigated areas of the developing countries. Future growth in crop yields for these areas will require micromanagement of other factors such as micronutrients, nutrients imbalances, organic matter supply, and soil analysis as well as environmentally sound management of nutrients from all sources including fertilizers. These factors will require relatively more knowledge and education on the part of farmers, as well as further research and extension efforts. In addition, further efforts must be focused on those geographical areas (eastern plains) where the adoption of existing technologies is modest or insignificant because potential for yield growth in such areas is relatively higher. These areas include those with high and medium rainfall as well as those with undeveloped ground water potential. However, extending the known technologies to these areas will be relatively more resource-demanding in terms of extension, education, infrastructure, and institutions on the other hand, yield growth in these areas will also create greater linkages in terms of employment creation and poverty reduction.

9. Implementing Biotechnology:

For the past 20 years, great hopes have been placed on the benefit to plant breeding from biotechnology. The 20th century was marked by marvelous progression in crop productivity inspired by Mandalian breeding. The 21st century will witness even more spectacular progress from a bright integration of Mandalian and molecular breeding. Modern biotechnology can intensify agricultural productivity in such a way that further reduces poverty, improves food and nutrition security and promote sustainable use of natural resources. While most of scientists and policy-makers identify that biotechnology is not sole solution for all food and agricultural production problems in India. It is the sole strongest puppet India right now has to address these problems. There are risks elemental in any technological interference. But public acceptance of new technologies is driven by perception of the risk rather than the physical actuality.

Indian policies towards most of issues related to biotechnology are far from being promotional. While it is promotional towards public research, it can be classified as preventive in case of intellectual property rights and trade, precautionary towards bio safety and permissive in case of food safety and consumer choice. In other words there are restrictions to the growth of biotechnology in India. The existing regulatory mechanism and lack of incentives on the application of biotechnology in agriculture and environment pollution control hamper the growth of biotechnology. India can reap the benefits of agricultural biotechnology if required policy actions on a number of fronts implemented. These embody policies to guide research for the benefit of the poor, administrating Intellectual Property Rights, and policies to address bio-safety, funding and result delivery issues. Therefore, there is need for win-win-win scenarios for all actors, and for creative efforts and enabling mechanism to benefit from gene revolution. For sake of today's poor, marginalized and hungry people and for future generations, we must not shrike these important challenges; relevant information on these issues must be available to the public. If these steps are not taken modern biotechnology will bypass the poor; opportunities for reducing poverty, food insecurity, and child malnutrition will not become reality; and the productivity gap between India and industrial countries agriculture will widen.

In fine, we need to explore every possible avenue to help increase food production. Indian farmers will readily embrace any technology as long as it is affordable and profitable. Advances in agricultural biotechnology have created opportunities for efficient crop improvement. However, this process necessitates caution to prevent unforeseen problems associated with it. Bio-safety issues need to be dealt with carefully. Comprehensive testing followed by open discussion could help create public confidence. It would be criminally irresponsible and morally reprehensible to throw away any valuable tool using archaic philosophical arguments and claiming hypothetical risks. New technology has always been resisted by no-changers down to the age. It is because few visionaries saw its potential and pressed ahead, that we enjoy the benefits of technology today. We would be better served if these problems are tackled using technology available to us, rather than let them be sidetracked because of fears of new technology.

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